K.7
11/04

Dam Removal Summit

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800 Kyd^3

97
456
800

Kalamazoo River Watershed Council
Dam Removal Summit November 8-9, 2004
Participants List

Sharon Baker	MDEQ, Surface Water Quality, Remedial Action
Thad Beard	Otsego City Manager
Robert Beck	Kalamazoo River Watershed Council
Jim Bernier	Senior Natural Resource Manager, Consumers Energy
Don Brown	Sierra Club, Kalamazoo Environmental Council
Elizabeth Browne	MDEQ, Manager, Superfund Section
Paul Bucholz	MDEQ, Kalamazoo River Site Manager
Doug Carter	MSU-KBS, Lake Allegan Kalamazoo River TMDL
Anne Marie Chavez	Allegan Conservation District Executive Director
Gale Dugan	Otsego Township Supervisor
Tyler Erickson	Altarum Institute, GIS Analyst
Jeff Eves	Menasha Paper Company, Environmental Affairs
Patricia Endsley-Fenn	Kalamazoo River Watershed Council
Sue Glynn	U.S. Senator Debbie Stabenow, Regional Manager
Dave Hamilton	MDEQ, Chief, Water Management Section
Steve Hamilton	KRWC, Biologist, Michigan State University
Sharon Hanshue	MDNR, Habitat Management Unit
Dayle Harrison	Kalamazoo River Protection Association, President
Jim Hayes	MDEQ, Dam Safety Unit
James Hegarty	Prein & Newhof
Jacquie Hejmanowski	USEPA, Region 5, Assistant Regional Counsel
Ed Higuera	Prein & Newhof
Linda Hicken	RMT, Inc., Senior Project Manager
Bill Hinz	Allegan County Environmental Health Director
Charles Ide	WMU, Environmental Institute Director
Rita Jack	Sierra Club, Waters Sentinels Project Director
Casey Jones	Allegan County Commissioner
Eric Kerney	Kalamazoo River Watershed Council
Greg Kinzer	Menasha Packaging, Environmental Officer
Paul Knoerr	Environmental Consultant, Hydrogeologist
Shari Kolak	USEPA, Region 5, Kalamazoo River Site Manager
Ken Kornheiser	Four Townships Watershed Council, President
Rich Koster	Kalamazoo River Watershed Council, President
Byron Lane	MDEQ, Dam Safety Division
Jen Lawton	NOAA, Coastal Protection & Restoration
Sandy Lipsey	State Representative, 60th District
James MacBroom	Senior Vice-President, Milone and MacBroom, Inc.
Scott Markham	Kalamazoo River Watershed Council
Sherry Mason	Gun Plain Township Manager
Jay Means	Great Lakes Environmental and Molecular Science Center

Paul Montney	Georgia Pacific, Inc.
Ginny Narsete	USEPA, Great Lakes National Program Office
Greg Peterson	Limno-Tech, Inc., Vice President
Steve Rheaume	USGS, Biologist, Hydrologic Studies Section Chief
Nicole Reid	Kalamazoo River Watershed Council
Kevin Ricco	Allegan County Parks and Recreation, Director
Ed Sackley	US Congressman Fred Upton, Kalamazoo Office
Sean Savage	Altarum Institute, GIS Analyst
Sara Schaeffer	MDNR, Wildlife Division
Larry Schmidt	EPA Region 5, Superfund Division Section Chief
Robert Schuchman	Altarum Institute, Vice President
Greg Sobel	Environmental Mediation Services, Senior Mediator
Jeff Spoelstra	Kalamazoo River Watershed Council
Steve Taplin	Terra Contracting, LLC, President
Max Theile	Allegan County Commissioner
Lou Thierwecter	Allegan County Commissioner
Mike Tenenbaum	Gun Lake Band, Potawatomi Indians, Environmental Director
Will Wawrzyn	Wisconsin DNR, Fisheries Biologist
Jay Wesley	MDNR, Fisheries Management Biologist
Steve Westenbroek	USGS, Wisconsin
Robert Whitesides	Kalamazoo River Watershed Council
Lisa Williams	USFWS, Contaminants Specialist
Erik Wilson	Plainwell City Manager

Per Dayle —

& after 30 yrs. find it hard to believe they haven't removed a bucketful of sediment out of Kalamazoo downstream of Saugatuck removed yet. "

& as you know the 'Kazoo is (one of the)? worst toxic sites in the great lakes "

(Total cleanup 500M to say 7 M annual? savings but not doing cleanup taken steps.

Our Presenters

$ 450K to more 10 yd³

James G. MacBroom, Milone and Macbroom

Jim earned BS and MS degrees in Civil Engineering from the University of Connecticut and is a registered Professional Engineer in five states. He is Vice President of Milone & MacBroom Inc, author of ***The River Book***, and teaches graduate courses in River Processes & Restoration and Applied Hydrology at Yale University. He has 30 years of experience in watershed management, open channel hydraulics, computer modeling, fluvial morphology, stream restoration, and tidal systems. Jim is a member of the ASCE Stream Restoration Committee and American Rivers Technical Advisory Committee, and a speaker at the annual University of Wisconsin continuing education course on dam removal.

He has planned, designed, and inspected many low head dam removal projects including earth, timber crib, and concrete structures, with a special interest in sediment management, channel evolution, and design of natural-like channels. Current 2004 projects include removal of two low head dams, studies at three Penobscot River basin dams in Maine, sediment scour studies for a dam in North Carolina, and construction of a fish bypass channel in Pennsylvania.

Jim has also participated in dam management projects, including inspecting and repairing unsafe or aging dams and providing fish passage at dams with fish ladders, ramps, and by-pass channels.

* less sedimt managmt by:
- controlled drawdown
- sedimt traps (+ dewatering

James R. Hegarty, Prein and Newhof (presentation)

Jim was the Big Rapids Dam Removal Project Manager for Prein & Newhof, a Grand Rapids-based engineering firm with 120 employees and regional offices in Muskegon, Byron Center, Kalamazoo and Holland.

- removed 10K yd³

Jim is a 1977 Civil Engineering graduate of The Ohio State University, and is a resident of Grand Rapids. He is a Fellow in the American Society of Civil Engineers, where he recently served as President of the ASCE Michigan Section. He is also a past President of the ASCE Western Michigan Branch. Jim is also a member of the National Society of Professional Engineers and the Michigan Water Environment Association.

estimated 80K yd³ cost 45K to remove

He is currently involved in a state-wide study to highlight the serious condition of many of our state's dams, and will be working this winter with the Village of Hersey and the City of Marshall on dam removal projects.

10K yd³ (clean)

Robert Schuchman, Ph.D., Altarum Institute

A Senior Vice President at the Altarum Institute (formerly the Environmental Research Institute of Michigan (ERIM)), Bob is also the Technical Director of the Environmental Group within the Environmental and Emerging Technologies Division, and an Adjunct Professor in the College of Engineering at the University of Michigan.

Earning a BS in Geological Oceanography and a BSE in Environmental Science Engineering at the University of Michigan (1974), Bob received in 1976 a MS in Remote Sensing at the University of Michigan. His PhD (1982) is in Natural Resources and Oceanic Science and was also from the University of Michigan.

Bob has spent the last thirty years utilizing remote sensing data to address a variety of earth applications including: oceanography; polar ice cap and glacier mapping; disaster assessments, remediation, and mitigation; and ecological risk assessment. His current research activities utilize dynamic geospatial based decision support systems to address human health consequences due to anthropogenic pollution.

Bob has served on numerous advisory panels for NASA, NOAA, University of Michigan, University of Bergen (Norway), National Academy of Science (Naval Studies Board, Committee for Earth Science), and the U.S. intelligence community. He was a member of the Environmental Task Force (ETF) and MEDEA, which was charged by Vice President Gore in 1992 to examine the utility of using classified data and systems to address environmental and climate change issues facing the United States. He has a patent pending, is the co-author of three books, and has in excess of 100 publications in refereed journals and other scientific contributions.

Steve Rheaume, United States Geological Survey, Michigan

Steve is the Hydrologic Studies Section Chief with the U.S. Geological Survey, Water Resources Discipline in Lansing, Michigan. He received a BS in Biological Sciences from Lake Superior State University and has completed Masters courses in stream ecology and invertebrate biology from Michigan State University.

Steve has been with the Federal Government for 28 years and has authored numerous reports on surface-water, ground-water, and bed-sediment quality, with recent publications in wetland and stream ecology.

Steve's presentation is titled: *Effects of dam removals on sediment transport and fate in the Kalamazoo River.*

Steve Westenbroek, United States Geological Survey, Wisconsin

Steve has worked on four dam removal projects in the past decade in Wisconsin. The most significant of these projects was the North Avenue Dam removal project. Removal of the North Avenue Dam was closely linked to contaminated sediment issues and Steve's analysis contributed to the decision to perform a partial dam removal of the North Avenue Dam.

Steve currently serves as a Hydrologist with the U.S. Geological Survey in Middleton, Wisconsin. He previously served as a project manager and water resources engineer for both the Wisconsin Department of Natural Resources, and for the consulting firm Baird and Associates, both located in Madison, Wisconsin.

Born and raised in nearby Holland, Michigan, Steve has a BS in Civil Engineering from the University of Michigan, and a MS in Water Resources Management from the University of Wisconsin-Madison. Steve is a registered professional engineer in the State of Wisconsin.

Will Wawrzyn, Wisconsin Department of Natural Resources

Will Wawrzyn has worked on 12 dam removal projects over the past 17-years decade in Wisconsin, and specifically the Milwaukee River basin, the most populated and diverse river basins in Wisconsin. In addition Will is involved with three Superfund Projects involving contaminated sediment removal in flowing streams. The most significant of these projects was the North Avenue Dam removal, a project which required a comprehensive analysis of environmental, engineering, social and economic issues.

Will has been working with the Wisconsin Department of Natural Resources for 27-years earlier as a water resources biologist and more recently as a fisheries biologist in the department's Milwaukee office.

Born and raised in Milwaukee, Wisconsin, Will has a BS in Biology and Water Resources Management from the University of Wisconsin - Stevens Point.

Jay Wesley, Michigan Department of Natural Resources

Originally from Grand Ledge, Michigan, Jay completed his BS in Fisheries Management from Michigan State University in 1993. He received a MS in Natural Resource Management from the University of Michigan in 1996. Jay has been working in Southwest Michigan with the Department of Natural Resources, Fisheries Division ever since.

Of eight years here, he spent six years as a Fisheries Management Biologist in Plainwell and is currently the Southern Lake Michigan Unit Manager. Jay has been directly involved with three dam removals or major drawdowns and has studied and proposed several others throughout Southwest Michigan.

Sharon L. Hanshue
Michigan Department of Natural Resources
Fisheries Division

Sharon is the supervisor for the Habitat Management Unit in Fisheries Division. She oversees staff administering the Natural Rivers Program and the hydropower relicensing review program. For the last several years, she has had the responsibility of implementing the Ludington Pumped Storage Plant settlement, including the construction of several public access sites, the exchange of 26,000 acres of land and the creation of the Great Lakes Fishery Trust, which has been operational since 1996. She is co-Chair of the Scientific Advisory Team serving the Trust.

She also represents the Division and Department in several major environmental contamination cases that involve habitat protection and restoration and she works on policy and program issues affecting the Great Lakes and inland aquatic habitat. Sharon has also developed a dam removal initiative in Michigan and is working with several communities and constituent groups interested in dam removal.

Sharon has been with the Fisheries Division since 1995. Previously she worked as a policy specialist in the Office of the Great Lakes; as a litigation specialist for the DNR Office of Litigation; and in the Surface Water Quality and Environmental Response Division programs now administered by DEQ.

She has a BS from Michigan State University in Environmental Sciences and Zoology and has worked for the DNR for 25 years.

Dayle Harrison, Kalamazoo River Protection Agency

Dayle has a Bachelors in Business Administration from Ferris State University and a Law degree from Thomas Cooley Law School. In 1977 he founded the Kalamazoo River Protection Association and has served as a board member of the West Michigan Environmental Action Council. Long a delegate to the Kalamazoo Environmental Council, Dayle has also served on the Michigan Water Quality Advisory Committee and on various state and game area forest committees. He has been involved with over a dozen superfund sites and the Great Lakes region and the East Coast over the last two decades. As a member of many national environmental groups, Dayle is a committed naturalist and supports restoring our rivers and forests both locally and nationally.

Position Paper on the Kalamazoo River

Kalamazoo River Watershed Council
(Revised November 25, 2003)

The Kalamazoo River Watershed Council is a nonprofit citizens' group that has spearheaded efforts to raise public awareness of the environmental condition of the river and its watershed, and particularly the problem of PCB contamination.

It is undeniable that progress on this Superfund Site has been extremely slow. However, we acknowledge that the excavation of the Bryant Mill Pond and the stabilization of the floodplain landfill sites were critical and successful first steps. Here we would like to outline our ultimate goals for remediation and restoration of the river system, and point out a few priorities for the immediate future.

Our ultimate goal is to restore the Kalamazoo River to the point where the waters are safe for recreation including full body contact swimming, where people can eat the fish to the same extent that they can in other inland waters, and where the health and reproductive success of wildlife such as eagles and mink are not impaired by PCBs or other contaminants. We seek to restore the Kalamazoo to a free-flowing river wherever possible, uninterrupted by the remnants of dangerous old dams that trap contaminated sediments and require costly maintenance. We envision that as its ecological condition improves, the river and its corridor will become a magnet for recreation and tourism and an economic asset for local communities, who will eventually reap benefits that will more than justify the costs of investing in river restoration.

But we are pragmatic and recognize that attaining this ultimate goal can only happen by a series of steps, first and foremost of which is a satisfactory resolution of the PCB contamination problem. The previous draft Remedial Investigation/Feasibility Study, which was staunchly opposed by a broad spectrum of stakeholders, offered alternatives that fell into two categories: *"Too little to be acceptable"* and *"Too much to afford all at once"*. We are looking forward to the EPA's new Proposed Plan and hope to see alternatives in the middle ground between Too Little and Too Much, and these must bring significant progress on cleanup of the entire 80+ miles of affected river channel. We realize that in some reaches the *"cure can be worse than the disease"* and we support tailoring the solution to each reach. If natural attenuation could be definitively proven to achieve our goals we would certainly consider its role, but so far we remain unconvinced. We support the Natural Resources Damage Assessment to help mitigate past and future damage done by PCB contamination.

We must comment specifically on the problem of the old dams that no longer serve any useful purpose. Dealing with the dams is absolutely fundamental to the cleanup effort because much of the contamination within the stream channel rests in sediments behind the dams. **We are convinced that removal of these dams and their most contaminated sediments is the only acceptable long-term**

solution, and we cannot approve any alternative that does not include dam removal. Yet we recognize that this must be carried out only after much study and with great caution. The idea of keeping the dams in place indefinitely as "in-stream hazardous waste storages" is extremely risky and therefore unacceptable, both because the PCBs are a current danger for fish and wildlife, and because dam retention leaves the contaminants vulnerable to catastrophic release in the event of a huge flood or dam failure. Furthermore, as long as the old dams remain it will be impossible to restore the natural flow regime of the river in those reaches.

In order to achieve the best possible remediation and restoration, **the most complete testing and monitoring program must be implemented**. Data on PCB levels in fish, birds, and other wildlife needs to be complete and current, collated, and made easily accessible. Another round of testing Kalamazoo River anglers, especially subsistence fisher folk, would be extremely helpful to have.

As the remediation of the river proceeds in the future under the transition of oversight from the MDEQ to the EPA and the GLNPO, we hope that these agencies are better able to interact with local stakeholders and thereby avoid the climate of mistrust and suspicion that has sometimes pervaded in the past. We offer our assistance in making this happen. **With support from the EPA, we will continue to act at the interface between policymakers and technical experts and the public.** We will work to ensure that unbiased decisions are made based on solid scientific evidence, and that appropriate monitoring is conducted as the cleanup proceeds. We will do our best to convey information and issues to the public in a balanced manner, and to advocate that path which is best for the long-term benefit of the local community and the environment.

ACKNOWLEDGMENTS

The Kalamazoo River Watershed Council would like to express our gratitude to Western Michigan University and the Great Lakes Environmental and Molecular Science Center. Dr. Charles Ide and his assistant, Enedelia Rodriguez, have been especially helpful, and the Fetzer Center staff has been wonderful to work with.

We are particularly grateful to GLEAMS for covering the cost of all the meals and refreshments for the Summit!

KRWC Board member Patricia Endsley-Fenn has spent many hours doing research and interviews to put together a detailed chronological history of the Kalamazoo River dams between Plainwell and Allegan. It is a work in progress and we would welcome comments, corrections, and critiques as we prepare it for use in our Educational Campaign that will soon be getting under way.

We are grateful to the City of Plainwell and its Water Treatment plant for the use of their property to launch watercraft for our tour of the Plainwell Dam impoundment.

We are also grateful to Otsego Township for the use of their building as a meeting place and staging area for the tours.

Thanks to Steve Taplin of Terra, Inc. for helping with the Monday Tours.

Special acknowledgment goes to Steve Rheaume for going to extra lengths to provide copies of the USGS Reports, especially the just-completed sediment transport study.

We wish to acknowledge the Great Lakes Commission and the Michigan ~~Department~~ of Environmental Quality, through whom we received the grant that has underwritten the cost of the Summit, and the Environmental Protection Agency, the ultimate source of the funds.

Finally, we thank all of you have come to take part!

Brief History of the Kalamazoo River Superfund Site & Dams

The Kalamazoo River watershed runs about 162 miles long through southwest Michigan and drains over 2,000 square miles from 10 counties. The river flows in two branches out of Jackson and Hillsdale counties, merges at Albion, and then continues another 123 miles before entering Lake Michigan at Saugatuck. Along the way it meanders through the cities of Marshall, Battle Creek, Kalamazoo, Plainwell, Otsego, and Allegan. Between Plainwell and Allegan the river drops around 100 feet or about 6.64 feet per mile (One study reported 4.9 fpm). With such a remarkable drop, it is not surprising that five hydroelectric dams were built along that stretch, with a larger one downstream from Allegan still operated by Consumers Energy.

Consumers Power decommissioned three of the five dams in the 1960s and sold them with their property to the Michigan Department of Natural Resources (DNR). In the mid-80s DNR had the powerhouses and everything but the sills removed. They intended to remove the sills but were stopped when it was realized that the impounded sediment was laden with polychlorinated biphenyls (PCBs).

The partial removal lowered the reservoirs so that previously impounded sediment was exposed in the floodplain.

In August 1990 the Allied Paper, Inc./Portage Creek/Kalamazoo River site was added to the National Priorities List. All areas have been extensively tested for PCBs and it has been estimated that 70% are in the Lake Allegan reservoir above the large downstream dam. The Plainwell and Otsego City impoundments are currently under study and feature some hotspots and considerable amounts of PCBs in the sediment.

Michigan Department of Environmental Quality (DEQ) was designated the lead agency and there was an agreement with the Potentially Responsible Parties (PRPs) that the latter would conduct and fund a remedial investigation/feasibility study. The RI/FS presented five alternatives and recommended the second, which called for some impoundment capping and bank stabilization, but mostly natural attenuation (burial) and monitoring.

None of these alternatives included removal of the dams and the RI/FS evoked a largely negative response from the public. At the request of DEQ the PRPs added a supplemental study which looked at a dam removal option and estimated a cost that appeared to be prohibitive.

In 2002 the lead was shifted to the Environmental Protection Agency (EPA) and last year EPA reported that they were considering seven alternatives, at least one of which included removal of the dam remnants. In response, environmental groups and state agencies were unanimous in calling for removal of the dams as an integral part of the final settlement. Partly for this reason EPA decided not to move ahead with a proposed plan until additional modeling of sediment transport is completed.

That new modeling project for the river is now being undertaken by Quantitative Environmental Analysis (QEA). Meanwhile, EPA has begun a facilitated discussion process bringing all parties to the table with a contracted mediator.

EPA had also contracted with USGS to study sediment transport in the event of a catastrophic dam failure. No study of sediment transport in the event of a controlled dam removal has been yet conducted.

The Kalamazoo River Superfund site has been extensively tested, sampled, and studied, and it is regarded as one of the most complex sites in the country. The State Department of Community Health has issued annual Fish Advisories warning against consumption of many of the Kalamazoo River fish since 1978. However, some local residents continue to catch and eat contaminated fish from the river.

Conversations and negotiations have proceeded at an accelerated level. Some participants have been involved with the process for nearly 30 years and the Kalamazoo River Protection Agency has been lobbying for a full cleanup for many years.

The Kalamazoo River Watershed Council, with the help of DEQ, produced the Remedial Action Plan (RAP) for the river in 1998.

The river is also an Area of Concern (AOC) as listed in the Great Lakes Water Quality Agreement between the United States & Canada. The Watershed Council is the Public Advisory Council for the AOC and works with the Statewide Public Advisory Council (SPAC). The Areas of Concern program lists 14 possible beneficial uses for a water body and the Kalamazoo River is reported to have 8 of these uses impaired, largely as the result of the PCB contamination.

Both DEQ and DNR want a restoration of the river for increased recreational uses and improved economic value to local communities.

The EPA's mandate in Superfund is remediation to an acceptable risk level. One option for remediation is to use former impoundments to confine and store contaminated sediment. The dam remnants, however, are in such bad shape that there is an increasing risk of failure and a large subsequent transport of PCBs downstream.

The Otsego City dam was in such disrepair that MEQ issued a repair or remove order. With substantial help from the paper companies, the city repaired the dam this spring at a cost of about $179,000.

The three dams owned by the DNR are on five-year "probation." But inspection of all three dams in April showed even more deterioration than previously thought.

The Watershed Council's goal is to provide evidence that all four dam remnants can be removed and the sediment effectively managed at a cost that will be acceptable to all parties.

STATE OF MICHIGAN
OFFICE OF THE GOVERNOR
LANSING

JENNIFER M. GRANHOLM
GOVERNOR

JOHN D. CHERRY, JR.
LT. GOVERNOR

August 20, 2004

The President
The White House
Washington, DC 20500

Dear Mr. President:

I read with interest Pennsylvania Governor Edward G. Rendell's letter of June 1, 2004, to you regarding the safety of this country's dams. His letter points out that 115 years after the catastrophic dam failure that led to the Johnstown flood of 1889, many citizens of our country still face danger from aging, dysfunctional, and hazardous dams. He asks that your administration, the other Governors, and Congress join him in a renewed commitment to prevent a recurrence of the events of that terrible day. I join Governor Rendell and ask you to propose to Congress a program to address the issue of our nation's crumbling dams.

The American Society of Civil Engineers reviewed infrastructure needs in the United States and, in its 2003 report card, gave dams a "D." The report states, "The number of unsafe dams has risen by 23 percent, to number nearly 2,600. There have been 21 dam failures in the past two years."[1] The Association of State Dam Safety Officials estimates the national cost of dam repair, replacement, or removal of nonfederally owned dams to be $36.2 billion.[2] Repair of a dam can easily cost hundreds of thousands of dollars, and for larger, more complex dams, millions of dollars. In some cases, dam removal may be the most environmentally beneficial and most economical option.

Michigan currently has at least 20 dams that we know have serious deficiencies. Of these, 11 are rated high or significant hazard potential, which means that their failure would likely result in loss of life, significant property damage, or serious environmental damage in the area downstream of the dams.

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[1] American Society of Civil Engineers, *Report Card for America's Infrastructure, 2003 Progress Report, An Update to the 2001 Report* (2003); <http://www.asce.org/reportcard/>

[2] Association of State Dam Safety Officials, *The Cost of Rehabilitating our Nation's Dams, A Methodology, Estimate & Proposed Funding Mechanisms* (December 2002), p. 3

Six dams in particular are the Redridge Dam in Houghton County, the Hamilton Dam in Genesee County, the Lyons Dam in Ionia County, and the Otsego, Plainwell, and Trowbridge Dams in Allegan County, all owned by units of government.

The nation's dams have been overlooked at significant cost to property owners, public safety, and the environment. The rapid deterioration of these dams demands our attention and our national investment, just as our highways, water supply and wastewater disposal systems, airports, and other important infrastructure have been supported with federal funding.

For quite some time we have heard from dam owners, particularly owners of small dams, many of which are small municipalities, who want to do the right thing but are unable to because of the expense. Now is the time for us to join together to help them and their neighbors who live with the constant threat of inundation by floodwaters due to dam failure. Meaningful federal assistance is imperative if we are to protect our citizens, address our infrastructure needs, and foster economic growth and environmental protection.

Sincerely,

Jennifer M. Granholm
Governor

JMG/pd

c: Michigan Congressional Delegation
Great Lakes State Governors
Mr. Steven E. Chester, Director, Michigan Department of Environmental Quality
Ms. Rebecca Humphries, Director, Michigan Department of Natural Resources
Ms. Gloria Jeff, Director, Michigan Department of Transportation

STATE OF MICHIGAN
OHN ENGLER
GOVERNOR
DEPARTMENT OF NATURAL RESOURCES
LANSING
K. L. COOL
DIRECTOR

December 6, 2002

Mr. William E. Muno, Director
Superfund Division
U.S. Environmental Protection Agency, Region V
77 W. Jackson Blvd. (SR-6J)
Chicago, IL 60604

Dear Mr. Muno:

SUBJECT: Kalamazoo River CERCLA Site Feasibility Study

We have recently learned that the U.S. Environmental Protection Agency (EPA) will soon be drafting a feasibility study for remediation of the Kalamazoo River and are concerned about some of the information circulating about this study. As you may know, the mainstem segment of river is currently characterized by one operating and several retired hydropower dams, three of the latter of which are owned by the Department of Natural Resources (DNR), Wildlife Division. In addition to this direct property interest in the river, we are also the public trustee for the natural resources of this system, thus have a vested interest in any proposed EPA activities on this system.

For years the DNR has intended to remove our dams, and in fact performed a partial removal in 1988. We were unable to complete this task as decisions and actions to address PCB contaminated paper wastes in the impoundments above the dams have not been made to date. The condition of the dams has continued to deteriorate while the PCB concerns have been investigated and alternatives for their removal developed.

We do not know if you realize the scope of debate that has occurred over the years concerning the future of these dams. We have previously provided your office with records from our files concerning the Kalamazoo River, specifically relating to the three DNR-owned dams dating back to 1966, just prior to state acquisition. Our records demonstrate that the DNR, as owner and natural resources trustee, has had long-standing interest in removing these dams for many reasons, not the least of which is that they are failing. In addition, my staff participated in many Kalamazoo River meetings and workshops with the various interests for the last several years and they have always advocated for remediation planning that allows for and anticipates removal of the DNR-owned dams.

Our intentions have not changed, yet the future of the dams again appears to be part of a debate involving the EPA and the Kalamazoo River Study Group (the responsible parties). Some have suggested that these dams be retained to serve essentially as in-stream waste lagoons. We see this as a very short-sighted solution to handling this significant contaminant problem that only delays the removal of these materials and leaves long-term resource problems and health risks in place. It is simply poor public policy to leave such problems to future generations to deal with, assuming the dams are maintained for that long, when we can solve the problem at this time. Thus, the only real solution is the complete removal of these materials from the system. As Director, let me stress that we cannot endorse a scenario that would convert one of the state's major river systems and all its public trust resources, into a "permanent" pollution disposal site in this way and we will actively oppose such a decision. The reality of this potential alternative is that it is not a permanent solution and will require constant inputs of capitol for dam maintenance along with the high risk of catastrophic dam failure and sediment release.

I expect you will consult with this agency directly if you are seriously considering this approach since the ramifications are significant. Please be assured that the DNR is a willing partner in river restoration on the Kalamazoo. We want to work with the EPA and the responsible parties on a remedy that will do more than minimize the public exposure to contaminants for a relatively short period of time. We would like your help in establishing a healthier, safer, and more productive river, and in seeing a lasting remedy implemented.

Again, please don't hesitate to contact our spokesperson on this site, Ms. Sharon Hanshue of the Fisheries Division at 517-335-4058, or you may call my office at 517-335-1270.

Sincerely,

K.L. Cool
Director

cc: Mr. Robert Beck, President, Kalamazoo River Watershed Council
Mr. Mark Brown, Kalamazoo River Study Group
Mr. Russell J. Harding, Director Department of Environmental Quality (DEQ)
Mr. Jim Sygo, DEQ
Mr. George E. Burgoyne, Resource Management Deputy, DNR
Ms. Rebecca Humphries, DNR
Mr. Kelley Smith, DNR

STATE OF MICHIGAN
DEPARTMENT OF ENVIRONMENTAL QUALITY
LANSING

JOHN ENGLER
GOVERNOR

RUSSELL J. HARDING
DIRECTOR

December 13, 2002

Mr. William E. Muno, Director
Superfund Division
United States Environmental Protection Agency
Region 5
77 West Jackson Boulevard (S-6J)
Chicago, Illinois 60604-3590

Dear Mr. Muno:

SUBJECT: Integrating the Fate of Plainwell, Otsego, and Trowbridge Dams in Kalamazoo River Superfund Site Feasibility Studies

The Michigan Department of Environmental Quality (MDEQ) wants to ensure that the United States Environmental Protection Agency (EPA) understands the State of Michigan's (state) position on the fate of three state-owned dams on the Kalamazoo River. In a January 18, 2002 letter to the EPA (enclosed), the Michigan Department of Natural Resources (MDNR) explained the state's long-standing intention to remove its dams and begin implementing its fisheries management plans. A package of background information on the MDNR's plan was included with that letter. We trust the MDNR letter was added to the EPA's administrative record and will be given appropriate weight during the feasibility study process for the Kalamazoo River Superfund site.

The MDEQ expresses full support of the MDNR's plans to remove its dams, which need to be removed for many reasons, including:

1) The MDNR purchased the dams and surrounding impoundment acreage with state funds, with the objective to improve the water quality of the Kalamazoo River. Provided that the sediment contamination in the river is appropriately addressed, removal of the dams will improve water quality.
2) The dams have clearly exceeded their design life; for some time now, they have not been usable for the purpose for which they were engineered.
3) The dams cannot be repaired to keep them safely in place for the long term. Although the state, in 2001, implemented interim measures to stabilize the dams, these measures are anticipated to last only another two to seven years. The dams are in such decay that the risk of catastrophic failure after that time is considerable.
4) The presence of dams restricts and hinders the MDNR in its duty to manage state fisheries and wildlife resources. The dams, like the contaminants, restrict public use of the resource and prevent the fishery from realizing its potential.

If the MDNR is unable to secure funding for dam removal in a timeframe compatible with the EPA's schedule, the MDEQ is committed to fund dam removal in conjunction with the EPA's implementation of site remediation in the vicinity of the dams. State environmental response funds would be requested to remove the three dams to take advantage of sequence, timing, monitoring, and other considerations associated with removal of sediment in the impoundments. Furthermore, when the state removes the dams, it will seek cost recovery from the site's liable parties to the fullest extent of state and federal law.

Given that the conditions of the dams are such that future repairs are not possible, ultimately, the dams will either fail or be removed. Thus, any alternative that depends on the perpetual existence of the Plainwell, Otsego, or Trowbridge dams cannot be deemed feasible, implementable, or permanent. The state will not support selection of any alternative that requires these dams to remain.

We look forward to working with the EPA in a partnership to ensure that remedial actions on the Kalamazoo River allow removal of the obsolete dams and make significant progress toward our common water quality goals. Dam removal is critical to the protection of the valuable resources entrusted to us by the people of Michigan and the surrounding Great Lakes states.

Sincerely,

Jim Sygo, Chief
Remediation and Redevelopment Division
517-335-1104

Enclosure

cc: Ms. Jo Lynn Traub, EPA
Mr. Gary Gulezian, EPA
Ms. Eileen Furey, EPA
Ms. Bonnie Eleder, EPA
Dr. Lisa Williams, United States Fish and Wildlife Service
Mr. Todd Goeks, National Oceanic Atmospheric Administration
Mr. Robert Beck, Kalamazoo River Watershed Council
Mr. Dayle Harrison, Kalamazoo River Protection Association
Mr. Sam Washington, Michigan United Conservation Club
Mr. Matthew Doss, Great Lakes Commission
Mr. Neil Gordon, Michigan Department of Attorney General
Ms. Sharon Hanshue, MDNR
Mr. Harold Fitch, MDEQ
Mr. Richard Powers, MDEQ
Mr. David Ladd, MDEQ
Mr. Andrew W. Hogarth, MDEQ
Ms. Elizabeth Browne, MDEQ

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

MAR 25 2003

REPLY TO THE ATTENTION OF

S-6J

Mr. Jim Sygo, Chief
Remediation and Redevelopment Division
Michigan Department of Environmental Quality
Knapp's Centre
P.O. Box 30426
Lansing, Michigan 48909

Re: MDEQ Position Regarding Dismantling of Michigan-Owned Dams as Part of the Remedial Action for the Kalamazoo River Operable Unit of the Allied Paper/Portage Creek/Kalamazoo River Superfund Site

Dear Mr. Sygo:

Thank you for your letter dated December 13, 2002, which communicates the position of the Michigan Department of Environmental Quality (MDEQ) regarding the appropriate disposition of the Plainwell, Otsego and Trowbridge dams in the remedy selection for the Kalamazoo River. These three dams are owned by the State of the Michigan and comprise part of the Allied Paper/Portage Creek/Kalamazoo River Superfund Site (the Site). Other dams located at the Site are owned by the cities of Otsego and Allegan. The United States Environmental Protection Agency (U.S. EPA) has been aware for some time that the State of Michigan strongly prefers that any remedy selected for the Kalamazoo River include dam removal as an integral component.

I want to assure you that U.S. EPA has included both your letter and an earlier letter from the Michigan Department of Natural Resources on the same matter in the federal Administrative Record for the Site. I want to assure you further that U.S. EPA will certainly consider the position of the State of Michigan regarding appropriate disposition of these dams during all stages of remedy selection for the Kalamazoo River. As you may know, U.S. EPA is currently drafting a Remedial Investigation/Feasibility Study (RI/FS) for the first two reaches of the Kalamazoo River. I have specifically requested that the FS for these two reaches include an alternative that would require dismantling of the Plainwell and Otsego ~~City~~ dams, and excavation and/or dredging of river sediments and floodplain soils that would be affected by dam removal. The FS will evaluate the degree of protectiveness of human health and the environment that could be achieved as a result of the dams' dismantling, the costs associated with such a course of action, and all other factors that the Agency must consider under the National Oil and Hazardous Substances Pollution Contingency Plan. As you know, one of these factors requires federal consideration of the State's position and key concerns about any preferred alternative (40 C.F.R. § 300.430(e)(9)(iii)(H)).

Until the FS is complete, U.S. EPA is not in a position to opine on what alternative will ultimately prove the most appropriate for the Kalamazoo River. It may well be that an alternative that is appropriate for one reach of the River is inappropriate, under the NCP's criteria, for another reach. Frankly, the State's position that it "will not support selection of any alternative that requires these dams to remain" seems a bit premature, since neither MDEQ nor Region 5 has yet had the chance to review and evaluate a complete alternative array. I hope that as time goes on, MDEQ will keep an open mind about the range of possibilities on the River.

In closing, I want to express my sincere hope that all of the state and federal agencies with a stake in the selected remedy for this River will continue to work together to ensure that an appropriate remedy is selected for the Kalamazoo, and that cleanup can occur in a timely fashion. The citizens of Michigan deserve no less. If you have any additional questions or concerns regarding the Site, please feel free to contact either myself or Shari Kolak, the Remedial Project Manager at (312) 886-6151.

Sincerely yours,

for William E. Muno, Director
Superfund Division

cc: Ms. Jo Lynn Traub, EPA
Mr. Gary Gulezian, EPA
Ms. Eileen Furey, EPA
Ms. Bonnie Eleder, EPA
Dr. Lisa Williams, United States Fish and Wildlife Service
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Mr. Neil Gordon, Michigan Department of Attorney General
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Mr. Harold Fitch, MDEQ
Mr. Richard Powers, MDEQ
Mr. David Ladd, MDEQ
Mr. Andrew W. Hogarth, MDEQ
Ms. Elizabeth Browne, MDEQ

EPA
United States
Environmental Protection
Agency

The Kalamazoo River Dams: Questions and Answers

Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site
Kalamazoo, Michigan September 2003

For more information...

on the Kalamazoo River dams, contact:

Don de Blasio
Community Involvement Coordinator
(312) 886-4360
(800) 621-8431 Ext. 64360
deblasio.don@epa.gov

Shari Kolak
Remedial Project Manager
(312) 886-6151
(800) 621-8431 Ext. 66151
kolak.shari@epa.gov

Site-related documents may be reviewed at:

Kalamazoo Public Library
315 South Rose
Kalamazoo, Mich.

Waldo Library
Western Michigan University
1903 West Michigan Avenue
Kalamazoo, Mich.

Charles Ransom Library
180 South Sherwood
Plainwell, Mich.

Allegan Public Library
331 Hubbard Street
Allegan, Mich.

Otsego District Library
219 South Farmer Street
Otsego, Mich.

Saugatuck-Douglas Library
10 Mixer Street
Douglas, Mich.

When possible, site information is also posted to: http://www.epa.gov/region5/sites

U.S. Environmental Protection Agency has been recently involved in several meetings sponsored by local environmental groups for the Allied Paper Inc./ Portage Creek/Kalamazoo River Superfund site. A concern frequently raised at these meetings is the future of the six dams in the 80-mile stretch of the river. Here are the answers to many of those questions.

Has EPA decided whether the dams should stay in place?

No, EPA has not made a decision about whether the dams should stay in place or be removed. EPA recently sent Michigan Department of Environmental Quality a draft Feasibility Study for the first two exposed sediment impoundments on the Kalamazoo River (Plainwell and Otsego City). MDEQ is in the process of reviewing and commenting on this draft. The draft FS included a draft "alternative array," which described seven remedial alternatives being considered for the first two impoundments. EPA will eventually select the remedy for these impoundments from the alternative array after it is finalized. Because the federal and state agencies are still deliberating about the draft FS (including the alternative array), it is not yet available to the public. EPA can assure you, however, that one of the alternatives the Agency is considering for these impoundments involves the removal of the Plainwell and Otsego City dams. After the alternative array is final, EPA will evaluate the alternatives according to the Superfund remedy selection process provided in the National Oil and Hazardous Substances Pollution Contingency Plan, referred to as the NCP.

How does this issue (the dams) fit into Superfund's cleanup plan selection process?

To fully understand the importance of this issue, let's first examine the process EPA uses to choose a cleanup plan. The NCP provides nine criteria to evaluate EPA's options in cleaning up a Superfund site. The first two criteria – called "threshold criteria" – are the most important. Every alternative must meet them in order to be eligible for selection. The first threshold criterion is overall protection of human health and the environment, and the second is compliance with applicable or appropriate and relevant legal requirements. So the question is, must be dams be removed to ensure adequate protection of people and the environment? EPA is studying this question very carefully.

The next five NCP criteria in the cleanup decision process are the "primary balancing criteria." After the threshold criteria are met, these are the most important in comparing alternatives. The five are:

- long-term effectiveness and permanence
- reduction of toxicity, mobility or volume through treatment
- short-term effectiveness
- implementability
- cost

The question of dams removal is relevant to all of these criteria. EPA must now:

- evaluate whether the dams must be removed to ensure long-term effectiveness of the cleanup
- evaluate the effects of dam and sediment removal on people and the environment
- assess the difficulty of removing the dams
- determine the cost associated with dam removal.

CERCLA (the Superfund law) and the NCP require all cleanups to be "cost-effective," which means that costs must be proportional to the plan's overall effectiveness. EPA is studying this issue too. There is more discussion on this point in other answers in this fact sheet.

The last two NCP criteria, called "modifying criteria," are state acceptance and community acceptance. They're called "modifying" because EPA can't thoroughly evaluate them until a proposed plan is issued. In this case, for example, EPA knows that the state and many people in the community favor removing the dams on the Kalamazoo. But since no plan has been proposed and no details on possible alternatives released, EPA cannot know for sure how any of the options will be received. EPA can't evaluate state or community acceptance until these two important stakeholders have the opportunity to consider all the relevant information.

What has EPA done about dams at other sediment sites?

In some cases, EPA required the dams remain in place, while at other sites, EPA has required the dams to be removed. Every situation is different, and every decision is based primarily on what's needed to protect people and the environment.

Can EPA implement a cleanup plan without state approval?

EPA always prefers to work with its state partners, so EPA strives to build consensus. But EPA doesn't necessarily need state approval of a cleanup plan to issue a final decision. There are a few things to remember:

- If Superfund money is to be used to pay for a cleanup, the state in which the site is located must provide certain assurances about cost-sharing and long-term operation and maintenance before work can begin.
- If Superfund money is used, the state is usually required to pay 10 percent of the cleanup costs, and pay for long-term operation and maintenance.
- If a Superfund facility was publicly operated at the time of disposal, the state is potentially responsible for half the cleanup costs.
- If those responsible for the contamination conduct or pay for the cleanup, then work can proceed without state approval. State assurances on cost-sharing are not necessary.

If EPA decides the dams should stay in place, is there anything the state can do to change EPA's decision?

Yes. Under the NCP, the state can ask EPA to amend its "record of decision," which is a public document that details the cleanup plan for the site. If EPA agrees that the changes requested by the state are necessary to provide adequate protection of human health and the environment, then EPA will amend its record of decision. If EPA concludes that the state's requested changes are an "enhancement," that is, they go beyond what the NCP requires, then EPA may amend the record of decision if the state agrees to pay all additional costs for the changes the state wants.

Is there any way the state can get the dams removed, other than through the Superfund cleanup process?

Yes. The state and other "Natural Resource Trustees," such as U.S. Department of the Interior, can make a claim for damages to the state's natural resources as a result of the PCB contamination in the Kalamazoo River. The trustees are assessing those potential damages now. A successful claim can mean substantial payments to the trustees. The money is usually used for restoration projects, and removing dams on the Kalamazoo could be one of those projects.

What is EPA doing to evaluate the dam issue?

EPA is doing a thorough internal evaluation. EPA is also paying for a study by U.S. Geological Survey to determine what would happen to the sediment behind the three state-owned dams if the dams were removed. USGS is trying to determine where the sediment would erode and aggrade within the current channel if the dams were to catastrophically fail. and how much sediment would become mobile if this were to happen. USGS is also studying other effects of removing the dams, and they are collecting data on the sediment and on discharges into the river at two points in the study area.

What questions will the USGS study not *resolve?*

- What would happen to Allegan Dam if the three state-owned dams are removed?
- What would happen to Lake Allegan, which already has sedimentation issues, if upstream dams are removed?
- Where could EPA dispose of significant quantities of contaminated sediment removed from the river? How much would that cost?

- How long would the dredging, excavation and disposal of floodplain soil and sediment take before the dams could be removed? EPA believes that such dredging and excavation could take several years.

When is the USGS study due to be completed?

EPA expects an initial draft in September 2003. The final USGS report is not due until September 2004.

What if EPA issues a proposed plan or record of decision before September 2004 that does not involve dam removal, but the USGS study shows that removing the dams would improve long-term effectiveness of the river cleanup, and not cost significantly more than leaving the dams in place?

If EPA issues a proposed plan or record of decision that does not involve dam removal before all USGS studies are completed, but the USGS studies contain information that makes EPA believe that it needs to reconsider its cleanup plan in any way (including dam removal), then EPA will re-evaluate it. Under the NCP, EPA can always revise a proposed plan and amend a record of decision based on important new information.

Can EPA require that the dams stay in place? Can EPA leave contaminated sediment in place if the state, which owns the property, wants it all removed?

EPA hasn't decided whether the dams should stay or be removed. But legally, EPA can require – as part of its proposed cleanup plan – that waste stays on-site. Again, the effect on people and the environment is a key issue. EPA policy is against moving wastes from a contaminated area to a clean area. The NCP process actually favors leaving untreated waste at the site, because moving waste from one site to another is not always the right thing to do. EPA can also require – as part of the cleanup plan – that the dams be repaired and maintained to keep the river in its present channel and prevent erosion of soil with high levels of PCBs.

If EPA requires the dams to remain in place, who will pay for the necessary repairs and long-term operation and maintenance of the dams?

The potentially responsible parties.

If EPA requires the dams to remain in place, does that mean PCB-contaminated soil and sediment will remain forever?

The risk to people and the environment will determine whether contaminated soil and sediment remain in place. Any decision on removing the dams will ensure that floodplain soil and sediment with PCBs above the ecological risk value and the human health risk value will either be removed or treated on-site. The ecological risk range for floodplain soil is 6 to 8 parts per million and for in-stream sediment is 0.5 to 0.6 ppm. The human health risk value for floodplain soil is 23 ppm. An example of an on-site solution is a cap, or an impenetrable barrier over the contaminated material.

What happens if the state decides to just take down these dams?

The state can't legally do that because of provisions of the Superfund law. The state is an owner of part of a Superfund site, and property owners need EPA's approval to do any cleanup work if EPA has already started a process called a "remedial investigation and feasibility study." Removing the dams would fall into the category of cleanup work. See Section 122(e)(6) for the relevant legal citation.

What is EPA considering when looking at the cost of removing the dams?

Because the state-owned dams are already partly dismantled, the major cost of removing them is the cost of transporting and disposing of contaminated sediment and soil. Transportation and disposal costs are estimated to range from 1 to 3 times the cost of dredging, depending upon the location of the final disposal site. A key problem at all sediment sites is how to dispose of the contaminated materials. At some sites – such as the Fox River in Wisconsin, where the disposal area is quite close to the site – sediment will be pumped through a temporary pipeline directly from the river to the disposal site. This results in a significant cost savings, especially if there's a large amount of sediment. At other sites, there's no proper disposal area nearby. So after the water is drained and treated, the sediment must be hauled – usually by truck – to a distant location. The cost of hauling sediment to a remote location can be quite high. To date, EPA does not have a nearby disposal area for the contaminated sediment and soil that would need to come out of the Kalamazoo in the event of dam removal.

Dam removal a renaissance for fish

Milwaukee River stretch thriving, DNR finds

By DON BEHM
dbehm@journalsentinel.com

Last Updated: Sept. 28, 2003

Grafton - Nearly three years after removing the Chair Factory dam on the Milwaukee River, state environmental researchers have more proof that such a move improves water quality and boosts fish populations. The most recent evidence is a greater variety of fish than ever before found in the now shallow, fast-flowing water upstream of Falls Road in this Ozaukee County community.

Where carp once dominated a sluggish, murky artificial lake that had formed behind the dam, few of the nuisance aliens remain in this stretch of river, said Will Wawrzyn, a fisheries biologist with the state Department of Natural Resources. Their place has been taken by hundreds of smallmouth bass, of all sizes, and more than a dozen additional fish species, including the rare greater redhorse and others not tolerant of muddy water, he said after five hours of wading in the river and counting its aquatic residents.

Wawrzyn and two other state fish scientists were the equivalent of aquatic census workers on Thursday. They sent an electric shock into the stream to stun the inhabitants so that they could more easily be counted. The transformation of the fish population they found here is to be expected within several years of eliminating a dam and restoring a more natural streambed and flow, according to Wawrzyn.

The 1988 destruction of the Woolen Mills dam in West Bend re-created a narrow channel and attracted a similar diversity of fish. Removal of the North Ave. dam in Milwaukee in 1997 allowed the stream to establish a more narrow, meandering channel through the former impoundment, and invited fish and aquatic insects not tolerant of pollution.

It is still too early to diagnose the full environmental impact of removing two other dams on the Milwaukee River, at Waubeka earlier this year and at New Fane in the Northern Unit of the Kettle Moraine in 2002, according to Wawrzyn. In all cases, however, taking out the barrier allows fish to move more freely in the stream and provides a more diverse bottom habitat, with sections of stone and gravel, than is found in the muddy pond of an impoundment, he said.

Other benefits came quickly upstream of Falls Road in Grafton. "There's more smallmouth than anything else, so that is showing us better reproduction from them," Wawrzyn said. Anglers had caught big smallmouth bass in the former impoundment, but its mud bottom was not where this fish spawned, or where its young grew to maturity.

Thursday's fish census found one- and two-year-old bass thriving in the mud-free, gravel and rock bottom. "The sheer numbers of smallmouth indicate better water quality," Wawrzyn said. He was not surprised by the surge in population. That's because aquatic insects are hiding beneath each stone and in every deep pool. "There are lots of invertebrates," he said. He found larvae of caddis fly, mayfly and stonefly species that are not tolerant of murky water and mud bottoms.

And where they go also go insect-eating fish, such as the greater redhorse. This fish, a type of sucker that is threatened with extinction in Wisconsin, prefers to lay eggs on gravel in moderately rapid water. The fish finds both upstream of Falls Road. Large numbers of redhorse coexist here with logperch, blacksided darter and stonecat - all fish that do not tolerate poor water quality and mud. Although stonecat is a species of bullhead catfish, it does not live in mud. "It likes stone," Wawrzyn said. "That's where its name comes from."

Wawrzyn and two DNR water resources specialists began Thursday's fish census at the Falls Road bridge. Equipment was loaded onto two plastic skiffs and pulled up and over rock ledges that form a series of short waterfalls. Once they reached the main channel above the falls, the two specialists, Mike Warwick and Matt Matrise, walked ahead of Wawrzyn carrying long poles mounted with wire hoops.

Each pole was connected to a generator on board a plastic skiff pulled by Wawrzyn. Warwick and Matrise held the wire hoops underwater, sending an electrical current into the water and temporarily stunning fish. The fish were netted and placed in buckets on the skiff. When the buckets were full, the researchers stopped to measure and weigh the fish, all of which had regained their senses. Each fish then was returned to the river.

They found few green sunfish and creek chub, another measure of the current health of this section of the river because both fish thrive in murky, sluggish water and can be found in abundance in other sections. In addition to the greater redhorse, they also found golden and shorthead redhorse, which also are insect eaters.

"The more we find, the better the habitat must be for them," Wawrzyn said. The census also found rock bass, emerald and spotfin shiners, and hornyhead chub.

Such variety and abundance of fish would not have been possible without removing the dam and draining the impoundment behind it, he said. The 8-foot-tall concrete wall had been declared a safety hazard in June 2000, and it was demolished at a cost of $96,000 in December of that year. A wooden dam was built on the site in 1847, and it was rebuilt with concrete in 1914.

Excerpts and Summaries of Articles in BioScience, August, 2002. Volume 52, NO. 8.

"What Goes Up, May Come Down", by Bruce Babbitt. pp 656-658

Former Secretary of the Interior Babbitt applauds the surge of new interest in dam removal but cautions that proponents of removal base their decisions on good science and sound decision-making.

"Rather than simply exchange the old simple approach to dams (build now, ask questions later), with a new, equally simple plan (remove now, analyze outcomes later), these initiatives have begun to recognize the socioeconomic and ecological complexity of what we are doing, and they affirm our obligation to the past, to each other, and to our surroundings. In carrying out our obligation, we can use what we have learned from the impacts of dams to help model, predict, and monitor the impacts of their absence."

"Decades ago, dams were built to meet certain laudable goals, goals few can object to even in hindsight. But goals are not enough, unless they are met and, more important, shown to have been met. *Dam removal, with equally laudable goals and carried out carefully with the best of intentions, cannot neglect the process of collecting and evaluating the evidence to determine whether the goals were met.* This process of evaluation is the cornerstone of adaptive ecosystem management."

"How Dams Vary and Why It Matters for the Emerging Science of Dam Removal", by Leroy Poff and David D. Hart. pp. 659-668.

The authors call attention to the fact that current paradigms for dam classification disguise a number of important differences within each classification. Their article features a number of helpful charts and graphs.

"Dam size also interacts with dam operations to influence a key variable, the hydraulic residence time (HRT), which in turn affects many different facets of the biophysical regime. The HRT is defined as the ratio of the storage volume of the reservoir to its flow-through rate, the latter being a function of natural inflow to, and human controlled outflow from, the reservoir. The HRT can potentially influence the settlement of sediment within the reservoir, the development of planktonic assemblages and processes, the transport of biota through the reservoir to downstream reaches, the type and rate of biogeochemical cycling, and the occurrence of thermal stratification."

"The rapid aging of dams (especially small ones) and the costs of maintaining old dams practically ensures that dam removal will continue at a brisk pace for the foreseeable future. *An open question is whether these removals will be guided by scientific principles aimed at river restoration and conservation or whether they will simply follow utilitarian economic principles."*

“Dam Removal: Challenges and Opportunities for Ecological Research and River Restoration,” by David D. Hart et.al. pp. 669-681

A summary of this article is clearly stated:

“The overall objectives of this article are to assess the current understanding of ecological responses to dam removal and to develop a new approach for predicting dam removal outcomes based on stressor-response relationships. We begin by explaining how a simplified spatial and temporal context can be helpful for examining dam removal responses. Three alternative approaches for predicting ecological responses to dam removal are then evaluated: (1) predictions based on studies of actual dam removals; (2) predictions based on studies of existing dams; and (3) predictions based on mechanistics and empirical models (e.g., sediment transport models).”

The article has a very long bibliography.

“Effects of Dam Removal on River Form and Process,” by Jim Pizzuto. pp. 683-691.

This is a very pertinent article with particular relevance for the USGS studies of geomorphology and sediment in the Kalamazoo River. Pizzuto is a fluvial geomorphologist at the University of Delaware and focuses his attention on the tools and strategies of predicting channel and sediment response to removal of dams.

Perhaps the most noteworthy section is the author’s review and critique of “numerical models of geomorphic response.” For instance, Pizzuto makes the observation that “nearly all existing models neglect many other important processes, including upstream propagation of knickpoints and headcuts; changes in width due to bank erosion or deposition; processes associated with floodplains, including overbank flows and associated sediment transport; and the influence of vegetation on sediment transport processes.”

Among his conclusions, the author notes that *“although a variety of useful models exist for predicting the geomorphic effects of dam removal, site-specific forecasts are unlikely to be reliable.”*

“A Geomorphic Perspective on Nutrient Retention Following Dam Removal”, by Emily Stanley and Martin Doyle, pp. 693-701.

Professors Stanley and Doyle have done some of the most pertinent fundamental research called for by the emerging science of dam removal studies. Just running through their online resumes can provide an idea of the scope of their work.

In this article, Stanley and Doyle “explore how dam removal may influence the movement of nitrogen and phosphorus in rivers . . . briefly considering nutrient transport in rivers and how reservoirs can affect nutrient processes. We then consider changes in nutrient dynamics following dam removal with respect to geomorphic adjustments caused by the removal.”

The authors make a number of points and tentative conclusions but the most pertinent ones seem to be in this excerpt:

"Changes in nutrient retention following dam removal should be complex, reflecting a balance between the dynamics of channel adjustment and the relative infolence of different channel stages on nitrogen and phosphorus processing. Following dam removal, affected sections of a river may consist of a series of reaches that have distinct and potentially contrasting influences on the form and amount of nutrients being transported downstream."

"Potential Responses of Riparian Vegetation to Dam Removal," by Patrick Shafroth et. al., pp. 703-712.

In this piece Shafroth and four other researchers discuss the effects of a sediment pulse released as a consequence of dam removal. In regard to riparian vegetation such a pulse may often be beneficial for downstream shorelines. In return, the right kind of vegetation can trap sediment and prevent its transport.

For their research into a upstream vegetation response to the sediment pulse, the authors reviewed a study of five small former impoundments in Wisconsin.

The more pertinent section of the article looks at management considerations , especially "managing for a beneficial transient sediment pulse."

The article is noteworthy for its excellent graphs and pictures.

"The Conceptual Basis for Ecological Responses to Dam Removal," by Stan Gregory, Hiram Li, and Judy Li, pp. 713-723.

In this article the authors focus almost entirely on large dams in the Western United States and the ecological consequences of removing them. What may be most pertinent here is the voluminous bibliography.

"A Framework for Estimating the Costs and Benefits of Dam Removal," by Ed Whitelaw and Ed MacMullan, pp. 724-730.

This article has perhaps the most immediate relevance to the Kalamazoo River, and the authors summarize it:

In this article, we describe principles we believe are effective in assessing the economic consequences of environmental management decisions. We then describe how those principles might be used for a cost-benefit analysis regarding dam removal using the dams on the lower Snake as a case study. We examine parts of the US Army Corps of Engineers draft cost-benefit analysis for these dams and suggest modifications to the Corps' analysis that would more fully account for relevant costs and benefits."

Whitelaw and MacMullan cite the instance of 78 economists who in September, 1998, sent a letter to the governors of the four Pacific states and the Premier of

British Columbia. In this letter these economists set down sex principles "that should guide the anlaysis of the economic consequences of removing or keeping a dam.

They also site the four Principles and Guidelines of the Corp of Engineers and join others in judging it to be outdated and too focused only on purely economic consequences and placing too little value on social and ecological factors.

"Enlisting the Social Sciences in Decisions about Dam Removal," by Sara Johnson and Brian Graber, pp. 731-738.

The authors cite a review of 14 cases of dam removal in Wisconsin which "found that decisions were commonly made with incomplete and inaccurate information and in emotionally charged and divisive atmospheres.."

They go on to add that "these findings support our experiences that the divisiveness of decision making is exacerbated when one or more of the following situations exist: when the idea of removal is new to the community; when the dam poses safety concerns, thus forcing a quick decision; and when outsiders (e.g. state agency personnel or conservation organizations with representatives not from the area) are involved in the decision process."

We might note that all three situations exist in the current discussion about the Kalamazoo River Superfund Site!

The section headings in the article are illuminating:

What's the big deal about small dam removal?
Drawing on the social sciences to effect changes in human behavior;
Social change: techniques for changing human behaviors;
Role of scientists in decisions regarding dams and rivers.

"Legal Perspectives on Dam Removal," by Margaret Bowman, pp. 739-747.

Margaret Bowman summarizes her article:

"This article outlines the legal issues associated with both decisions about whether or not to remove a dam and decisions about how to remove a dam. It then examines how implementation of environmental restoration activities such as dam removal fits into our existing legal system and how environmental laws may need to evolve to address the increasing interest in environmental restoration."

The author identifies three aspects of dam removal operations with pertinent legal ramifications:

1) Dam Safety proceedings
2) Hydropower Dam Regulation
3) The Endangered Species Act

Ms. Bowman points out that "because many of the laws that are triggered by a dam removal decision focus on environmental *protection*, they are not easily adapted to the environmental *restoration* activities associated with dam removal, and some laws actually discourage environmental restoration efforts."

She points to the Edwards Dam removal on the Kennebec River in Maine as a clear example where environmental restoration goals conflicted with environmental protection laws. And then she concludes,

"The resulting question is how to allow positive deviations from the environmental status quo while not weakening laws and creating loopholes that will allow more negative deviations from the status quo. Basic exemptions from environmental protection laws for restoration projects is not advisable, because environmental restoration projects do have impacts that need to be reviewed and minimized."

MICHIGAN

Citation

Laws regarding Michigan dam safety are found in Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended. Draft rules have been promulgated.

Definitions/Dam Classifications

Dam means an artificial barrier, including dikes, embankments, and appurtenant works, that impounds, diverts, or is designed to impound or divert water, or water and any other liquid or material in the water, and that is or will, when complete, be 6 feet or more in height, and has or will have an impounding capacity at design flood elevation of 5 surface acres or more.

Dam height means the difference in elevation measured vertically between the natural bed of a stream or watercourse at the downstream toe of the dam, or, if it is not across a stream channel or watercourse, from the lowest elevation of the downstream toe of the dam to the design flood elevation or to the lowest point of the top of the dam, whichever is less. (Sec. 31503 [10])

Hazard Classification

High Hazard Potential: Failure may cause serious damage to inhabited homes, agricultural buildings, campgrounds, recreational facilities, industrial or commercial buildings, public utilities, main highways or class I carrier railroads, or where environmental degradation would be significant, or where danger to individuals exists with the potential for loss of life. (Sec.31503 [11])

Significant Hazard: failure may cause damage limited to isolated inhabited homes, agricultural buildings, structures, secondary highways, short line railroads, or public utilities, where environmental degradation may be significant, or where and danger to individuals exists. (Sec. 31505 [5])

Low Hazard: failure may cause damage limited to agriculture, uninhabited buildings, township or county roads, where environmental degradation would be minimal, and danger to individuals is slight or nonexistent. (Sec. 31504 [2])

Jurisdiction/Powers of Department

The Department of Natural Resources is responsible for the safety of dams in Michigan. The department has the power to regulate the construction, reconstruction, repair, alteration, removal, abandonment, and operation of dams; to provide for the inspection of dams; to provide for the protection of natural resources and the public trust; and to prescribe remedies and penalties. (Part 315, 1994 PA 451) The department may in an emergency take any necessary actions, including repair, drawdown, breaching or cessation of operation to protect public safety, natural resources and the public trust. Department personnel have conditional right of entry to a dam site. (Sec. 31527) The department may limit dam operation or order dam removal in order to protect public health, safety, welfare, natural resources and the public trust.

Permit/Approval Process

A person shall not construct, enlarge, repair, reconstruct, alter, remove, or abandon any dam without first applying to the department for a permit and providing information that the department determines necessary for the issuance of a permit. Applications shall be accompanied by appropriate fees according to the following schedule: (Sec. 31509 [3] [4])

New construction, reconstruction, and enlargement projects:

Height > 6 feet but < 10 feet	\$500
Height > 10 feet but < 20 feet	\$1000
Height >20 feet	\$3000

Repair, alteration, removal and abandonment projects:

Major Projects	\$200
Minor Projects	\$100

A licensed professional engineer shall prepare all plans and specifications, except for minor projects. (Sec. 31508[1]) Upon receipt of an application for a permit, the department shall accept or reject the permit within 60 days, or 120 days if a public hearing is held (Sec 31512). Required spillway design criteria are found in Sec. 31516.

After construction of a permitted dam and a statement from the project engineer advising that the dam was built in conformance with approved plans and specifications, the department shall inspect and file written notice of approval for the dam. (Sec. 31517)

Inspection Process

An owner shall submit to the department inspection reports that are prepared by a licensed professional engineer which evaluate the condition of the dam. The inspection reports shall be submitted as follows:

- Once every 3 years for high hazard potential dams
- Once every 4 years for significant hazard potential dams
- Once every 5 years for low hazard potential dams

The department shall establish an inspection schedule and notify all owners in writing when inspection reports are due. Instead of engaging a professional engineer, a local unit of government that owns a dam may request the department to do a visual inspection of the dam and prepare a report.

Owner Non-Compliance/Violations/Penalties

The Dam Safety Act provides remedies and penalties, both criminal and civil, for violations of the act, permit conditions, and department orders. (Sec. 31524 and 31525) Included in these remedies is authorization to the department to cause an inspection report to be prepared and to recover costs in a civil court in the event that a dam owner refuses to submit an inspection report as required by the Dam Safety Act. (Sec. 31518 [6])

Emergencies

Owners of high and significant hazard potential dams are required to have an emergency action plan submitted to the department and to the local emergency services coordinator. (Sec. 31523) Dam owners are required to notify the department of emergencies at the owner's dam.

The director may order an owner to immediately repair, draw down, breach, or cease operation of a dam where a dam is in imminent danger of failure and is threatening the public health, safety, welfare, property, natural resources or public trust. (Sec. 31521)

Liability

This act shall not be construed to relieve an owner of any legal duty, obligation, or liability incident to the ownership or operation of a dam or impoundment. (Sec. 31529) A state Supreme Court ruling provides a level of liability to state employees.

Oversight

Any person aggrieved by any action or inaction may request a hearing of the matters involved. The hearing shall be conducted by the department in accordance with the Administrative Procedures Act of 1969. (Sec. 31526)

Miscellaneous

The Dam Safety Act also authorized enforcement of inspection report recommendations, exempts dams under Federal jurisdiction, and requires promulgation of administrative rules, including rules to establish minor project categories.

DAM SAFETY INSPECTION REPORT

PLAINWELL DAM NUMBER 1
ID #00491
SE 1/4 SEC 24. T1N, R12W
KALAMAZOO RIVER
ALLEGAN COUNTY

OWNER: Michigan Department of Natural Resources

OPERATOR: Tyson Edwards
Allegan State Game Area
4590 118th Avenue
Allegan, Michigan

HAZARD POTENTIAL CLASSIFICATION: High

INSPECTED BY: Michael W. Oakland, P.E.
Stephen R. Amrein, P.E.
Todd W. King, P.E.
Camp Dresser & McKee
Detroit, Michigan

INSPECTION DATE: April 16, 2004

REPORT DATE: July 12, 2004

PREPARED BY: Michael W. Oakland, P.E.
Todd W. King, P.E.
Registration No. 35557
Camp Dresser & McKee
One Woodward Avenue, Suite 1500
Detroit, Michigan 48226
Tel: (313) 963-1313

INTRODUCTION

This report summarizes the results of a visual inspection of the Plainwell Dam on the Kalamazoo River in Plainwell, Michigan (Figure 1). The dam is being inspected as required by the Dam Safety regulations that stipulate high hazard potential dams be inspected every 3 years or 3 years following significant repairs. Repairs were made on the Plainwell dam during the winter and spring of 2001 to temporarily stabilize the dam in the anticipation that PCB contaminated sediments would be removed within 5 years allowing the complete removal of the dam. No substantial progress has been made with respect to the removal of the sediments, and thus, for the purposes of this report, it is assumed that the dam must meet the requirements of Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451. This report is limited to a visual investigation and review of previous inspection reports, plans, and data which are available. This report should not be considered as an in depth engineering investigation.

The visual inspection was made by Michael Oakland, Stephen Amrein and Todd King of Camp Dresser & McKee. Paul Bucholtz (Michigan Department of Environmental Quality), James Hayes (Dam Safety Unit for the Michigan Department of Environmental Quality) and John Lerg, Scott Hanshue, Tyson Edwards and Sara Schaefer (Department of Natural Resources) were also present. Conditions during the time of the visit were sunny with temperatures around 60 degrees Fahrenheit. The water level at the dam was relatively low with about 6 inches of water flowing over the spillway. The flow of water obscured the spillway surface and downstream apron.

CONCLUSIONS AND RECOMMENDATIONS

The Plainwell Dam is in poor condition and has inadequate spillway capacity. The dam is overgrown and has signs of erosion (see site sketches and photographs, Appendices A and B, respectively) in several locations due to overtopping as well as inadequate slope protection on the upstream face. The concrete continues to deteriorate in the areas where rough surfaces from the former partial demolition are exposed. Failure of the dam would have potential severe environmental impacts as contamination currently isolated in impoundment sediments would be mobilized and transported downstream.

If the Plainwell Dam is not to be removed in the very near future, the following recommended repairs should be completed as soon as possible. These repairs are listed by priority:

- Reconstruct the walls and embankment to enlarge the spillway capacity to meet current requirements. At the same time, the deteriorated concrete training walls at each side of the spillway and the interior piers should be repaired and surfaces protected against further deterioration.

- The entire left embankment should be re-graded, removing all trees and brush, and shaped with an even crest with upstream and downstream slopes no steeper than 3 horizontal to 1 vertical. Debris below the former powerhouse location should be excavated and replaced with low permeability fill which extend into the abutment to form an adequate cutoff to seepage. The upstream slope of the re-graded spillway should be protected by riprap with grass planted over the remainder of the spillway.

- The exposed right bank upstream of the spillway should be cutback and stabilized by riprap to avoid further loss of soil.

- Erosion on the downstream side of the right training wall should be filled and re-graded.

- Debris caught in the spillway and just upstream of the spillway should be removed.

- Cut brush on the left embankment near the former powerhouse should be removed.

PROJECT INFORMATION SECTION

The Plainwell Dam and associated powerhouse were constructed in 1902 as part of a hydroelectric facility. In 1908, the spillway failed and was rebuilt. The original powerhouse was destroyed by fire in May 1919 and was rebuilt in March 1921.

About 1965, the dam was decommissioned as a power generator and ownership of the dam was transferred from Consumers Power Company to the Michigan Department of Natural Resources (DNR). The DNR raised and jammed the spillway control gates in the open position at that time to lower the upstream impoundment to the fixed weir level. In 1986, DNR removed the powerhouse structure and some of the spillway about the fixed crest. At the same time, the embankment slopes adjacent to the spillway and powerhouse were cut back to an approximately 4 horizontal to 1 vertical slope.

The dam is approximately 1215 feet long. Looking downstream, the dam is comprised of a former concrete hydroelectric generation section to the far left, a left earthen section, a concrete fixed spillway, the former lift gates, and a right earthen section. The section lengths are approximately 72, 175, 40, 176, and 750 feet long, respectively. The elevation datum used in the previous inspection reports is the National Geodetic Vertical Datum (NGVD) (formally the USGS datum). Elevations mentioned in this report will be based on the NGVD.

No design drawings are available for the Plainwell Dam. However, based on descriptions in previous inspection reports and observations made during our site visit, it appears that the dam consisted of the following:

- A service spillway consisting of eight 20 feet wide lift gates with an additional 40 feet wide ogee spillway section. A buttress was constructed between each spillway section. The top of the ogee spillway section was set at elevation (El.) 706.0 with the sill of the lift gates at El. 702.5. The original buttress between the lift gates had a top at El.715.5 and a walkway spanned the gates at El. 717.0. The spillway and sill was about 23 feet wide with an additional 12 feet of concrete apron. The top of the apron was at El. 696.5. The thickness of the concrete is not known, but is believed to be founded on the glacial deposits which underlie the area. A wall existed about 20 feet upstream of the fixed spillway parallel to the dam.
- A powerhouse near the left abutment formed the left portion of the dam with the top of the structure at El. 717.0. The powerhouse included three turbines with grates and raceways to each turbine. The powerhouse was approximately 31 feet wide and was founded in the glacial deposits which underlie the area. The lowest depth of the powerhouse is not known.
- A retaining wall extending from the right of the powerhouse to the spillway formed the upstream face of the embankment. The top of the wall was set at El. 714.0 and the earth embankment slopes gently downstream into a former island in the river. The slope is grass covered with some saplings and brush. Larger trees exist on the former island downstream of the dam. A shallow slope also exists upstream of the wall. The height and slope of the upstream slope varies and is also grass covered.
- A right embankment consisting of a long earthen embankment up to 12.5 feet in height with a crest at El. 715.5. A 5.5 feet high concrete wall formed the upstream side of the embankment. The embankment was constructed with a 3 horizontal to 1 vertical upstream slope and a 2 horizontal to 1 vertical downstream slope and a crest width of about 11 feet. A gravel road now exists on the embankment crest. The remaining embankment is grass covered with some small trees and brush along the embankment.

As part of the 1986 demolition, the powerhouse has been largely removed along with the spillway walls and buttresses to just above the level of the fixed spillway at about El. 707. A low area in the embankment is present at the site of the former powerhouse. The slopes in this area are approximately 4 horizontal to 1 vertical.

PRIOR INSPECTIONS

The dam was inspected in May 1979 as part of the Phase I inspection program administered by the Army Corps of Engineers. The Phase I inspection was conducted by Owen Ayres and Associates, Inc. The inspection was conducted prior to demolition of the gates and power house.

Since the 1986 demolition, the dam has been inspected by the Dam Safety Unit in September 1993, August 1994 and September 1996. The 1996 inspection report by the DNR contained the following observations:

- Trees and brush were growing within the embankment between the powerhouse area and the spillway and on the right embankment. However, with the lowering of the pool level, the right embankment is essentially above impoundment level.

- The left training wall of the spillway has two large vertical cracks and several smaller cracks. However, none of the cracks were separated or showed signs of differential movement.

- Erosion is evident along embankment areas cut as part of the demolition. The erosion is considered due to flood water overtopping the dam.

The dam was inspected again in November 1998 by CDM for purposes of assessing interim repairs required to maintain the stability of the dam over the next 5 to 10 years during removal of PCB contaminated sediments upstream of the dam to allow for the dam removal. The inspection recommended that the spillway capacity be increased by lowering a section of the fixed crest ogee spillway, installation of a cutoff wall to reduce seepage through the powerhouse foundation and grouted riprap to be added in an eroded area frequently overtopped. This work was completed in the spring of 2001 and periodic inspections approximately every 6 months have been conducted since that time to assess the interim condition of the dams.

FIELD INSPECTION

Observations at the time of the site visit are summarized as follows:

- In general, the left embankment is very uneven with a low area at the former powerhouse, rising to a high area in the vicinity of the former island and then dropping back down to a cut slope adjacent to the left training wall of the spillway. The embankment generally appears stable other than sloughing on the upstream slope near the training wall. No lateral movement or tipping of the training walls was observed. The long embankment on the right side of the dam is reportedly no longer necessary due to the lower spillway height, however it too appears generally stable with no movement to the concrete wall which forms the upstream face along much of the embankment.

- The left embankment of the dam has areas overgrown by brush and trees.

- The upstream slope of the embankment near the left training wall is very steep and is eroded at the toe.

- The left embankment does not have adequate erosion protection on the upstream slope and erosion is also present on the downstream slope around the edges of the grouted riprap placed adjacent to the left training wall.

- At least one rodent hole was found on the downstream slope of the embankment.

- The area around the former powerhouse is low and continues to be an area overtopped during storm events. While not leaking at the time of this visit, recent visits during higher pool conditions have shown leakage through the embankment at the former powerhouse location and through the left abutment. Continuing uncontrolled leakage could cause internal erosion of the embankment, ultimately leading to dam failure. An eroded pathway exists on the downstream slope in this area. Cut brush has also be left on the embankment in this area.

- The left spillway training wall is spalled in areas with two large cracks on the upstream end. While the piers where inaccessible and prevented detailed inspection, it was evident that these partially demolished structures were also deteriorated. The piers where also overgrown.

- Debris was caught on the spillway which included a large log. A timber cribbing mat was also caught on something, possibly an old intake, just upstream of the spillway.

- The bank along the right side of the stream has several recent sloughs. The area behind the right training wall is eroded with a gully about 1 foot deep.

It was not possible to confirm the condition of the downstream apron, stream bed below the apron or spillway buttresses. However, from what could be observed, no signs of instability are apparent. Based on the portions of the dam observed, it appears that the dam embankments and remaining spillway are generally stable. However continued overtopping of the unprotected portions of the embankments could result in further erosion.

STRUCTURAL STABILITY

Conditions at the dam do not pose an immediate structural threat. The dam embankments, walls and spillway appear to have adequate stability against sliding or slope failure. However, long term continued loss due to erosion during overtopping and sloughing of the upstream slope and right stream bank will result in possible future instability.

Similarly, continued deterioration of the concrete forming the piers and training walls, will result in loss of stability of the spillway structure.

HYDROLOGY AND HYDRAULICS

Prior to the recent modifications to lower the fixed crest ogee spillway, the previous inspection report noted that the design discharge for the spillway is the 0.5 percent chance flood discharge of 11,000 cubic feet per second (cfs) which would have resulted in a flood stage at about El. 709.1 at the dam which is about 2.1 feet above the top of the spillway abutments and the current embankment grade at the former powerhouse. The capacity of the spillway at that time with a flood stage at the top of the spillway abutment walls was 5700 cfs which is approximately equal to the estimated 10 percent flood.

The recent modifications to the spillway have reduced the overtopping during the design flood to about 1.6 feet which proportionally increases the existing spillway capacity to about 7720 cfs.

The spillway capacity is still less than required to meet the design storm requirements resulting in flow over the low areas of the dam. In particular, this excess flow is over the former powerhouse area of the left embankment and at slightly higher stages, over embankment areas immediately behind the left and right training walls.

Currently, each of the overflow areas has limited erosion protection consisting of vegetation cover, loose riprap and grouted riprap in the downstream area of the area behind the left training wall. This erosion protection is considered to be inadequate for the frequency of the overtoppings. The spillway capacity must be increased to the design storm condition.

OPERATION AND MAINTENANCE

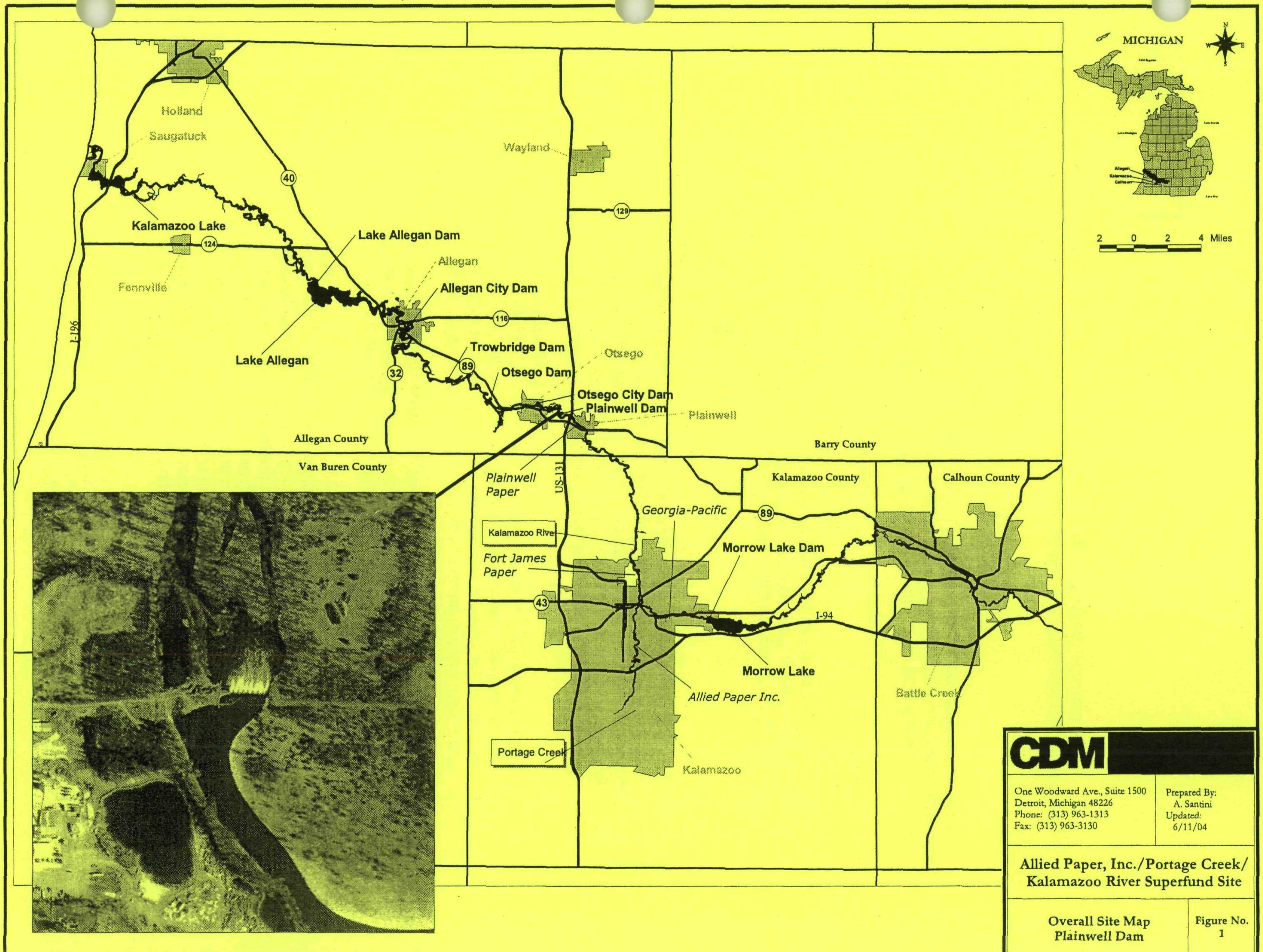
Operation of the dam is by Wildlife Division staff from the Allegan State Game Area. According to MDEQ and MDNR staff, a written operation and maintenance (O&M) plan has been developed for the dam and is on file with the Dam Safety Unit.

EMERGENCY ACTION PLAN

According to MDEQ and MDNR staff, an emergency action plan (EAP) has been prepared for this facility. A copy is on file with the Dam Safety Unit and with appropriate DNR offices. This EAP should be reviewed annually and updated as necessary.

APPENDIX

A sketch of the observations made at the time of the visit (Appendix A) and photographs from this inspection (Appendix B) are attached.



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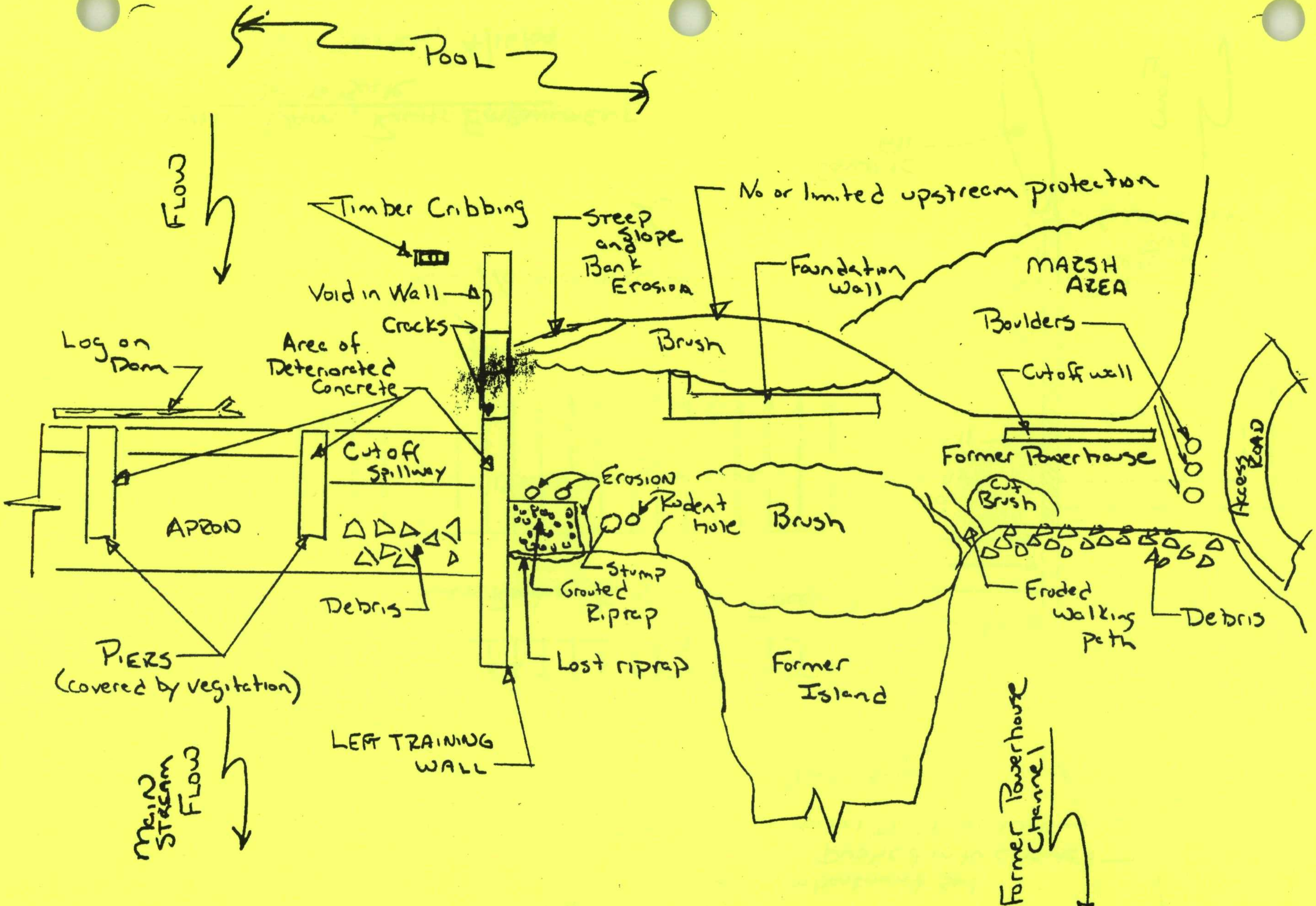
Otsego
Otsego Dam
Otsego City Dam
Plainwell Dam
Plainwell
Allegan County
Van Buren County
Barry County
Plainwell Paper
US-131
Kalamazoo County
Calhoun County
Georgia-Pacific
Kalamazoo River
Fort James Paper
Morrow Lake Dam
I-94
Morrow Lake
Allied Paper Inc.
Battle Creek
Portage Creek
Kalamazoo
CDM
One Woodward Ave., Suite 1500
Detroit, Michigan 48226
Phone: (313) 963-1313
Fax: (313) 963-3130
Prepared By:
A. Santini
Updated:
6/11/04
Allied Paper, Inc./Portage Creek/
Kalamazoo River Superfund Site
Overall Site Map
Plainwell Dam
Figure No.
1



PLAINWELL DAM, LEFT EMBANKMENT

NOT TO SCALE

Inspection Field Sketch, 4/16/64

CDM

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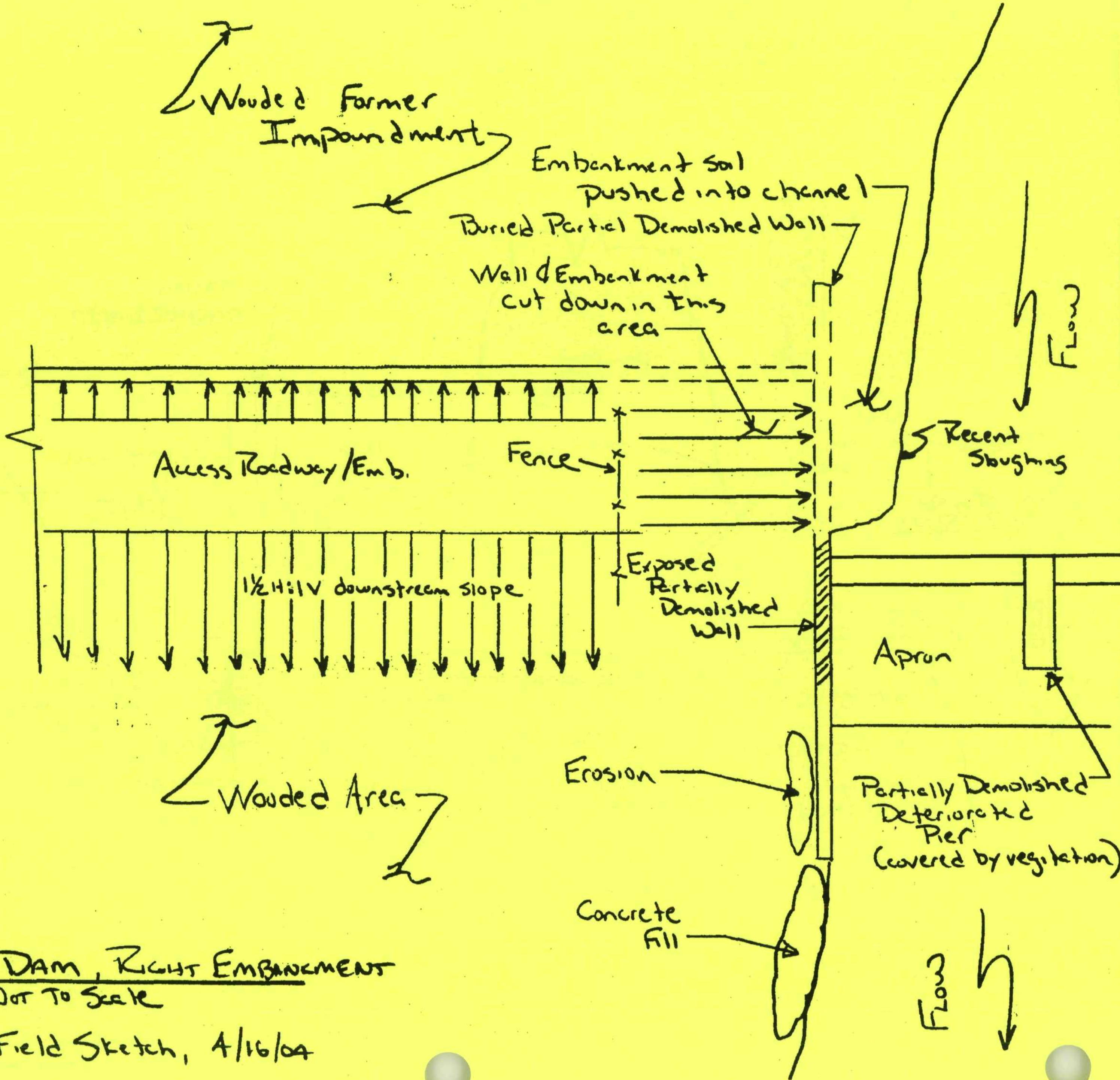


PLAINWELL DAM, RIGHT EMBANKMENT
NOT TO SCALE

Inspection Field Sketch, 4/16/04

Plainwell Dam – Right Side

Right Training Wall with Sloughing Streambank behind

Spillway Piers

Plainwell Dam - Right Side

Partially Demolished Deteriorated Concrete at Right Training Wall

Plainwell Dam - Left Side

Crack in Left Training Wall

DAM SAFETY INSPECTION REPORT

OTSEGO DAM
ID #00619
SW 1/4 SEC 17. T1N, R12W
KALAMAZOO RIVER
ALLEGAN COUNTY

OWNER:	Michigan Department of Natural Resources
OPERATOR:	Tyson Edwards Allegan State Game Area 4590 118th Avenue Allegan, Michigan
HAZARD POTENTIAL CLASSIFICATION:	High
INSPECTED BY:	Michael W. Oakland, P.E. Stephen R. Amrein, P.E. Todd W. King, P.E. Camp Dresser & McKee Detroit, Michigan
INSPECTION DATE:	April 16, 2004
REPORT DATE:	July 12, 2004
PREPARED BY:	Michael W. Oakland, P.E. Todd W. King, P.E. Registration No. 35557 Camp Dresser & McKee One Woodward Avenue, Suite 1500 Detroit, Michigan 48226 Tel: (313) 963-1313

INTRODUCTION

This report summarizes the results of a visual inspection of the Otsego Dam on the Kalamazoo River in Otsego, Michigan (Figure 1). The dam is being inspected as required by the Dam Safety regulations that stipulate high hazard potential dams be inspected every 3 years or 3 years following significant repairs. Repairs were made on the Otsego dam during the winter and spring of 2001 to temporarily stabilize the dam in anticipation that PCB contaminated sediments would be removed within 5 years allowing the complete removal of the dam. No substantial progress has been made with respect to the removal of the sediments, and thus, for purposes of this report, it is assumed that the dam must meet the requirements of Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451. This report is limited to a visual investigation and review of previous inspection reports, plans, and data which are available. This report should not be considered as an in depth engineering investigation.

The visual inspection was made by Michael Oakland, Stephen Amrein and Todd King of Camp Dresser & McKee. Paul Bucholtz (Michigan Department of Environmental Quality), James Hayes (Dam Safety Unit for the Michigan Department of Environmental Quality) and John Lerg, Scott Hanshue, Tyson Edwards and Sara Schaefer (Department of Natural Resources) were also present. Conditions during the time of the visit were sunny with temperatures around 60 degrees Fahrenheit. The water level at the dam was relatively low with about 6 inches of water flowing over the spillway. The flow of water obscured the spillway surface and downstream apron.

CONCLUSIONS AND RECOMMENDATIONS

The Otsego Dam is in very poor condition and has inadequate spillway capacity. Sinkholes continue to form along the left and right training walls of the spillway indicating severe seepage along the outside of the walls. The seepage is confirmed by water exiting the walls on the downstream side of the spillway (see site sketches and photographs, Appendices A and B, respectively). Previous undermining compromised the foundation piles on the downstream end of the training walls to the point that a portion of the wall on each side had to be replaced with a temporary sheet pile wall and it is believed that this process is continuing on the upstream portions of the dam. In addition, the lower downstream apron of the spillway is cracked and sections of the apron have recently broken off. It appears that the pile foundation support below the apron is also deteriorating. In addition, both the left and right embankments are overgrown in areas and have signs of erosion in several locations due to overtopping or excessive foot traffic. The dam has inadequate slope protection on the upstream face. The concrete continues to deteriorate in the areas where rough surfaces from the former partial demolition are exposed. Failure of the dam would have potential severe environmental impacts as contamination currently isolated in impoundment sediments would be mobilized and transported downstream.

If the Otsego Dam is not to be removed in the very near future, the following recommended repairs should be completed as soon as possible. These repairs are listed by priority.

- Reconstruct the entire spillway structure, replacing the walls, slab and fixed crest weir on a new foundation. As part of the reconstruction, the new spillway should be enlarged to meet the currently capacity requirements for the design storm.
- The entire left and right embankments should be re-graded, removing all trees and brush, and shaped with an even crest with upstream and downstream slopes no steeper than 3 horizontal to 1 vertical. Debris below the former powerhouse location should be excavated and replaced with low permeability fill which extend into the abutment to form an adequate cutoff to seepage and to avoid loss of ground into the penstocks and basement of the former structure. The upstream slope of the re-graded spillway should be protected by riprap with grass planted over the remainder of the spillway.

PROJECT INFORMATION SECTION

Otsego Dam was constructed in 1903-1904 as part of a hydroelectric facility. A downstream, pile-supported, reinforced concrete apron was added to the dam's spillway around 1917. The powerhouse was rebuilt and new generators were installed in 1925 but it is not known if other work was performed on the dam during this period. In 1965, the generators were removed from the facility and ownership of the dam was transferred from Consumers Power Company to the Michigan Department of Natural Resources (DNR). The DNR raised and jammed the spillway control gates in the open position in 1970 to lower the upstream impoundment to the fixed weir level. The records on the dam are not clear on whether the spillway control gates and support members, spillway catwalk, and powerhouse were removed during a military training exercise around 1975 or whether the work was performed along with re-grading by a contractor around 1985.

The dam is approximately 700 feet long. Looking downstream, the dam is comprised of a left earthen section, a concrete service spillway, a center earthen section, a former concrete hydroelectric generation section, and a right earthen section. The section lengths are approximately 170, 128, 135, 110, and 157 feet long respectively. The elevation datum used on the 1903 design plans is unknown but the local datum of elevation (El.) 90 is around 690 feet above the National Geodetic Vertical Datum. Elevations mentioned in this report will be those used on the original design plans.

The design plans show the earth embankment sections to have a crest at elevation (El.) 88.00. The crest width is 16 feet for the right and center embankments and 20 feet for the left embankment. The upstream slope of the embankment is 2.5:1 while the downstream slope is 2:1. An 18 feet high plain concrete core wall extends along the earthen sections parallel to and approximately 16.5 feet upstream from the centerline of the embankment. The base of the concrete core wall is at El. 69.00 with six inch timber sheeting extending the cut off down to about El. 53.00.

The service spillway has a clear opening of 118 feet. It was originally divided into five 20 feet wide bays with 4.5 feet wide buttresses between each bay. The concrete buttresses had a top elevation of 87.17 and extended from 2.5 feet in front of the spillway foundation to 18 inches downstream of the front face of the sill. Both the front and rear end of the buttresses were beveled to form 2.5 and 3 feet points, respectively. The buttresses have been removed down to or below the level of the weir. The downstream portion of the buttresses has been removed to a level where they are no longer visible above a one foot depth of water. Each of the five bays had a 12.5 feet high taintor gate which sealed against the top of a 3.5 feet wide broad crested weir. The weir has sloping upstream and downstream faces. The top of the weir is at El. 71.80. It has a base width of 10.5 feet and is monolithic with 18 feet downstream plain concrete apron. The top of the apron is at El. 69.00. A 6 inch high, 2 feet wide concrete sill starts 11.75 feet from the weir. Oak piles on a 5 feet spacing along the centerline of the spillway and approximately 7 feet spacing along the centerline of the dam supported the weir and apron. Two piles in each of the last three rows in each bay were allowed to project 2.8 feet above the apron, apparently to serve as baffle blocks. The projecting portion of the piles have been removed or worn away as they are not visible in one foot of water. Six inch timber sheet piling, approximately 16 feet deep, was to be constructed at the upstream face of the weir and a similar sheet pile cutoff wall 26 feet deep was planned 3.5 feet upstream from the end of the apron.

A pile supported timber grid, fastened to a timber embedded in the apron just behind the sill, extended approximately 24 feet at the level of the apron and approximately another 24 feet at a 14 inch lower level. Plans indicate the upper timber grid was replaced around 1917 with a 23.5 feet long reinforced concrete apron extension supported on the original timber grid piles. There are also indications that the lower timber grid has also been replaced with a concrete apron but this has not been confirmed.

The spillway concrete side walls (called abutment walls herein to be consistent with previous inspection reports) are approximately 100 feet in length. They extend approximately 25 feet upstream of the weir and 70 feet downstream of the original spillway apron. The upstream and downstream walls are supported by a single pile line with piles approximately 6 feet on center. The wall at the weir and apron section is supported by a twin line of piles with the piles approximately 5 feet on center. A 6-inch sheet pile cutoff is connected to the spillway upstream cutoff wall and extends to the downstream end of the side walls. The length of the sheeting is 18 feet between the spillway cutoff walls and 24 feet downstream of the spillway downstream cutoff wall. The design plans do not show a connection of the left embankment cutoff wall to the spillway and spillway abutment wall cutoff sheeting. The abutment walls were removed to approximate El. 76 in 1985.

The hydroelectric generating section of the dam has a length of 98 feet between side walls and a width of approximately 33 feet. A concrete gravity dike was constructed along the upstream face of the section with a top at approximately El. 68.42. Timber cutoff walls were present at the upstream and downstream faces of the section. The structure and dike were supported by oak piles. A generator building was adjacent to the section on the center embankment. Pile supported plain concrete training walls extending upstream and downstream were present at each end of the hydroelectric generating section. The center and downstream portion of the walls had timber cutoff walls beneath them. The original design plans do not show definite connections between the various cutoff walls. The superstructures of these units have been removed above El. 76.4 and the debris used to fill the lower portions of the structure and to create a 2:1 upstream slope to the area and a 1.5:1 downstream slope turning the section into a quasi-rubble filled dam.

PRIOR INSPECTIONS

Since the 1986 demolition, the dam has been inspected on or about a three year cycle by the Michigan Department of Environmental Quality (MDEQ) Dam Safety Unit and the Wildlife Division Staff of DNR. The inspections occurred in 1990, 1993 and 1996. The 1996 inspection report and the letter dated November 2, 1998 by MDEQ contained the following observations:

- The downstream end of the spillway left abutment wall and a portion of the apron are undermined for approximately 25 feet exposing the wooden foundation piles.
- The spillway left abutment wall contains a vertical crack approximately 25 feet upstream of the end the wall. The crack has a slight separation but indicates no differential movement.
- The junction of the above wall and the spillway apron is severely cracked. Flow through this crack is scouring away the earth around the wall foundation piles and under the apron. An eleven foot tree limb was inserted under the apron during the inspection. It was noted that the apron is also founded on wooden piles which are partially exposed.
- The spillway right abutment wall contains an open vertical crack approximately 25 feet upstream of the end the wall. The crack is separated about 3 inches with the downstream portion about 2 inches higher and 2 inches inward of the upstream portion of the wall. It was noted that most of the movement occurred prior to 1990. Between October 1995 and May 1996 about 1/4 inch of additional movement has been observed at the crack.
- Due to high tailwater conditions, the degree of undermining of the downstream end of the spillway right abutment wall could not be determined.

- Erosion gullies caused by flood overtopping of the cut back embankment slopes areas are present at the spillway abutments.

- Sinkholes are present along the spillway abutments. Sink holes were found during the 1990 inspection and filled in 1991. They reappeared before the 1993 inspection.

- No evidence of seepage was found on the embankment slopes or downstream toe.

- Minor seepage is present at cracks in the downstream face of the powerhouse foundation.

- Cut brush and trees have been left on the embankments.

The general condition of the dam was assessed to be poor. The undermining of the left downstream abutment wall, the recurring sinkholes, and the associated leakage were deemed to pose a serious threat to the stability of the dam.

The dam was inspected again in November 1998 by CDM for purposes of assessing interim repairs required to maintain the stability of the dam over the next 5 to 10 years during removal of PCB contaminated sediments upstream of the dam to allow for the dam removal. The inspection recommended that the cracked and displaced lower sections of the spillway training walls be removed and replaced with temporary steel sheet pile walls, to remove some of the existing brush on the dam and to fill sinkholes as they appear.

In addition, to enhance dam stability beyond the next five years, jet grout stabilization of the soils behind the training walls was also recommended. The grout would cut off flow behind the walls which is causing the sinkholes and stabilize the soils. The grout stabilization recommendation was not incorporated as it was believed that the dams would be removed within a five to ten year time-frame. The remaining recommendations were implemented and this work was completed in spring of 2001. Periodic inspections approximately every 6 months have been conducted since that time to assess the interim condition of the dams.

FIELD INSPECTION

Observations at the time of the site visit are summarized as follows:

- In general, the right embankment is very uneven with a low area at the former powerhouse, rising to a high area in the vicinity of the former island and then dropping back down to a cut slope adjacent to the right training wall of the spillway. The embankment generally appears to be stable, other than sloughing on the upstream slope near the training wall. The wide embankment on the left side appears to be stable with no signs of movement or sloughing. The temporary sheet pile walls continue to appear to be in good condition with no signs of movement.

- Slight movement of the left training wall is believed to have occurred based on a small, recent, slight separation between the wall and the grout backfill placed around the wall at the time of the 2001 repairs.

- The training walls are spalled in numerous locations and the upstream end of the right training walls is eroded to a depth of about 1-1/2 inches at the normal water level.

- Sinkholes continue to form along the back side of both the left and right training walls. The sinkholes have grown in size substantially since the last visit indicating increasing seepage below or behind the walls and continued failure of the cutoff walls below the dam.

- Cracks in the soil, near the downstream end of the left training wall, indicate a scarp forming all the way to the ground surface over the voids created from the internal seepage erosion.

- Seepage through the wall on both the left and right sides confirm the flow of water behind the walls.

- A crack previously observed in the middle of the lower apron appears to have grown. The crack, which can only be seen during very low flow conditions, seems to have increased from about ½-inch in width to about 1-1/2 inches in width near the left training wall. A section of the apron about 4 square feet in area is missing from the downstream right corner of the lower apron.

- The left and right embankments of the dam both have areas overgrown by brush, trees and large stumps on the upstream slopes. A portion of the downstream slope on the left embankment is also heavily overgrown with brush and trees.

- The upstream slope of the embankment near the right training wall is eroded at the toe and water is entering the embankment from behind the training wall though the demolition debris at the upstream face.

- Neither embankment has adequate erosion protection on the upstream slopes.

- At least one rodent hole was found on the right embankment and two on the left embankment.

- The area around the former powerhouse is low and continues to be an area overtopped during storm events. While not leaking at the time of this visit, recent visits during higher pool conditions have shown slight leakage through the embankment at the former powerhouse location. Continuing uncontrolled leakage could cause internal erosion of the embankment, ultimately leading to dam failure.

It was not possible to confirm the condition of the downstream apron, stream bed below the apron or spillway buttresses. It is reported that a large plunge pool exists downstream of the dam and may be contributing to lateral movement, causing the cracking of the downstream apron.

STRUCTURAL STABILITY

Given the condition of the visible piles at the spillway, it should be assumed that the existing spillway does not have adequate stability to meet current dam safety requirements. In particular, it appears that the lower apron is extremely vulnerable at this point. However, loss of the apron is not believed to pose an immediate threat to the dam, although rapid action would be required at that time to prevent the full loss of the structure.

Continued erosion due to seepage/flow behind the training walls will continue to result in sinkholes. The ground surface behind the walls should be considered unstable. People should be restricted from this area.

Continued deterioration of the concrete forming the piers and training walls, will also result in loss of stability of the spillway structure.

The dam embankments appear to be generally stable with no signs of displacement or sloughing. However, the area of the former powerhouse does overtop during storm events and while no significant erosion is currently visible, long term exposure to this event could cause instability of the embankment.

HYDROLOGY AND HYDRAULICS

The inspection report noted that the design discharge for the spillway is the 0.5 percent chance flood discharge of 13,900 cfs. This would result in a flood stage at about El. 80.75 at the dam which is about 4.3 feet above the top of the spillway abutments and the current embankment grade at the former powerhouse. The capacity of the spillway with a flood stage at the top of the spillway abutment walls is 3,840 cfs which is approximately equal to the estimated annual flood.

Currently, each of the overflow areas has limited erosion protection consisting of vegetation cover, loose riprap and grouted riprap in the downstream area of the area behind the left training wall. This erosion protection is considered to be inadequate for the frequency of the overtoppings. The spillway capacity must be increased to the design storm condition.

OPERATION AND MAINTENANCE

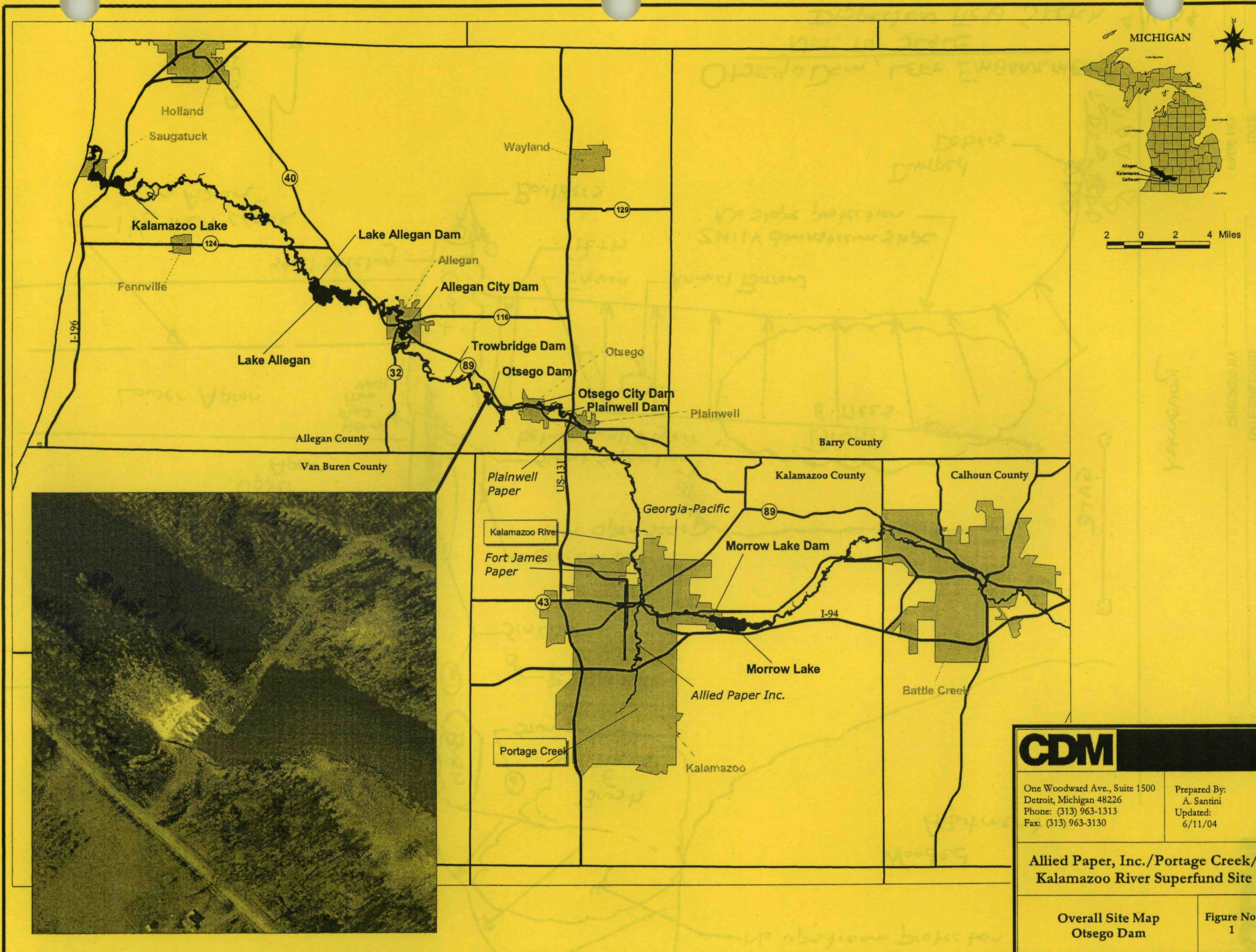
Operation of the dam is by Wildlife Division staff from the Allegan State Game Area. According to MDEQ and MDNR staff, a written operation and maintenance (O&M) plan has been developed for the dam and is on file with the Dam Safety Unit.

EMERGENCY ACTION PLAN

According to MDEQ and MDNR staff, an emergency action plan (EAP) has been prepared for this facility. A copy is on file with the Dam Safety Unit and with appropriate DNR offices. This EAP should be reviewed annually and updated as necessary.

APPENDIX

A sketch of the observations made at the time of the visit (Appendix A) and photographs from this inspection (Appendix B) are attached.



CDM

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Prepared By:
A. Santini
Updated:
6/11/04

**Allied Paper, Inc./Portage Creek/
Kalamazoo River Superfund Site**

**Overall Site Map
Otsego Dam**

**Figure No.
1**

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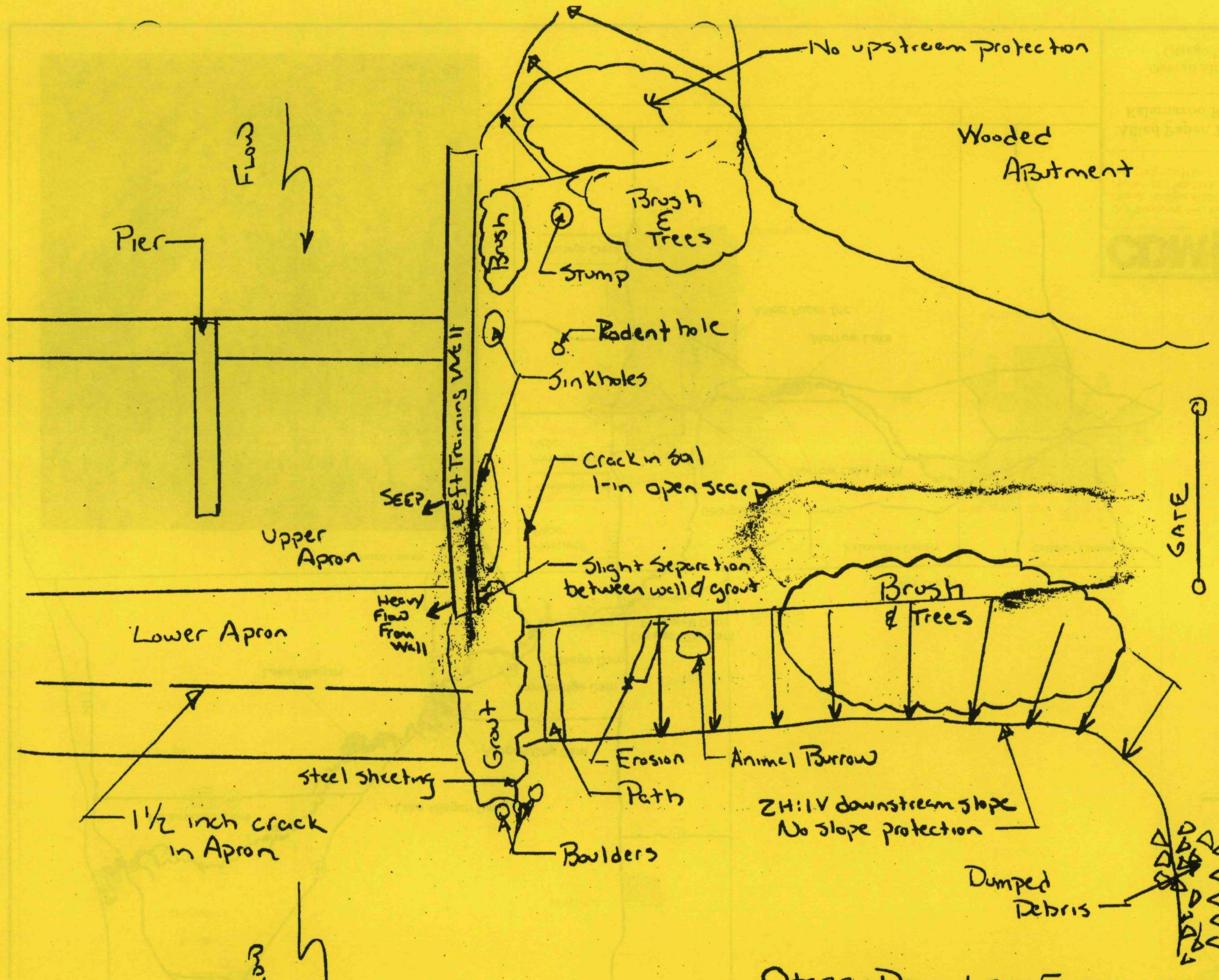

Otsego Dam, Left Embankment
Not to Scale
Inspection Field Sketch 4/1/04

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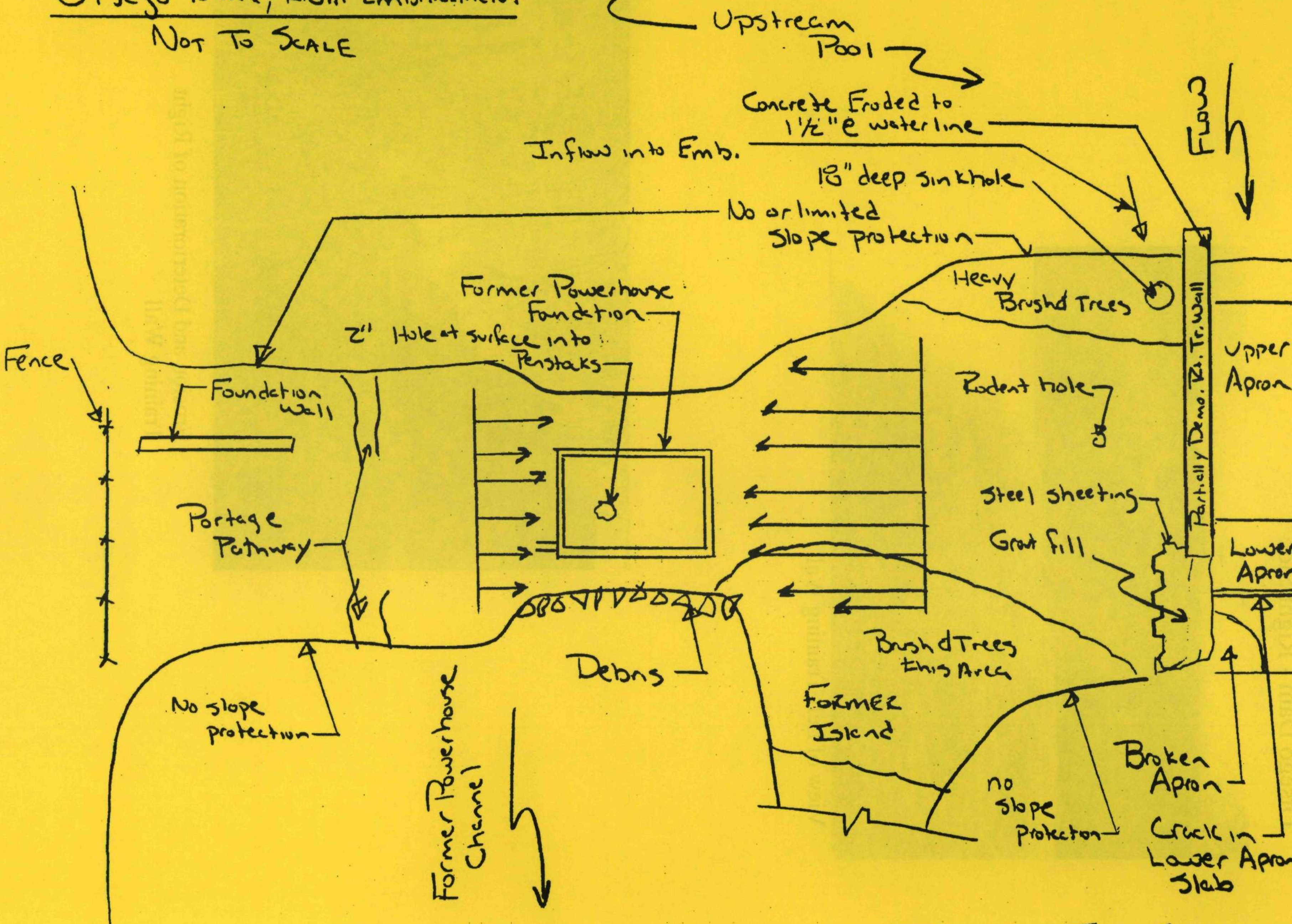
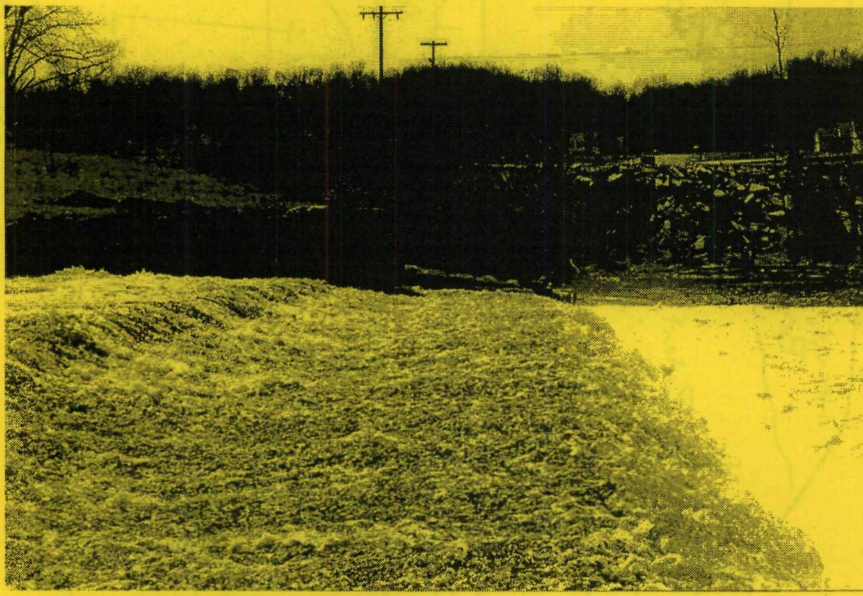
Otsego Dam, Right Embankment

Not To Scale



Inspection Field Sketch
4/16/04

Otsego Dam - Right Side



View of Left Training Wall

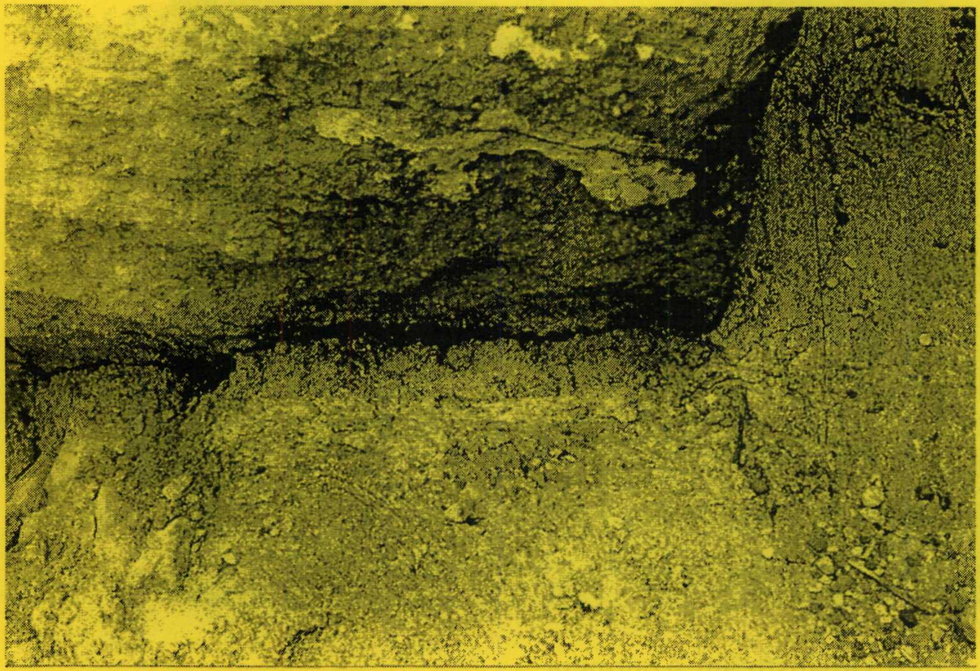
Erosion and Deterioration of Right Training Wall

Otsego Dam - Left Side

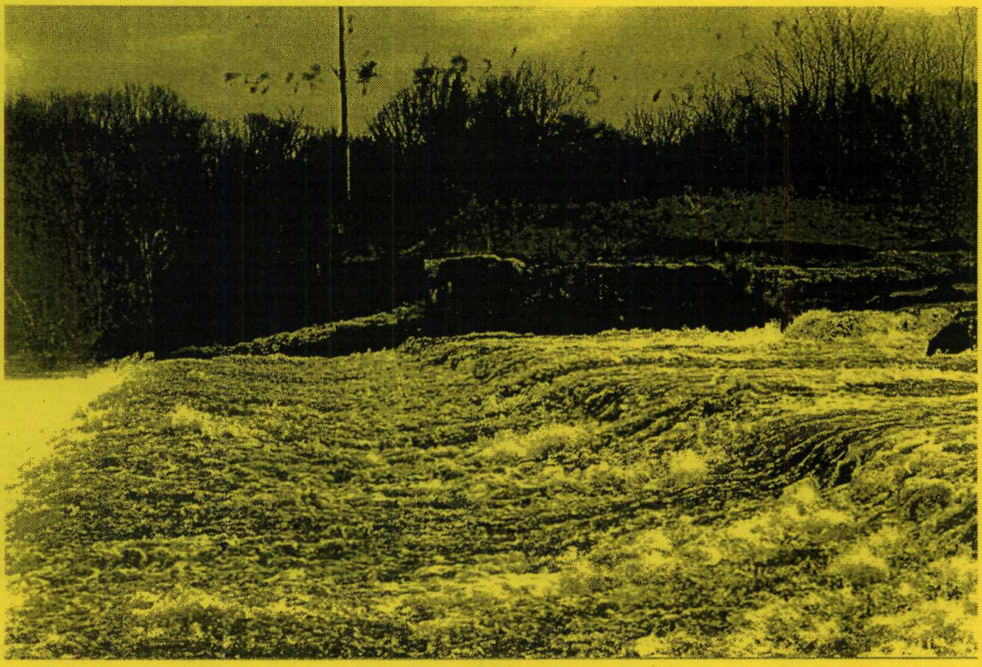
Rubble on Left Downstream Abutment

Scarp found Next to Sinkhole at Downstream end of Left Training Wall

Otsego Dam - Left Side



Crack indicating Wall Movement



View of Right Training Wall

DAM SAFETY INSPECTION REPORT

TROWBRIDGE DAM
ID #00604
SW 1/4 SEC 12. T1N, R13W
KALAMAZOO RIVER
ALLEGAN COUNTY

OWNER:	Michigan Department of Natural Resources
OPERATOR:	Tyson Edwards Allegan State Game Area 4590 118th Avenue Allegan, Michigan
HAZARD POTENTIAL CLASSIFICATION:	High
INSPECTED BY:	Michael W. Oakland, P.E. Stephen R. Amrein, P.E. Todd W. King, P.E. Camp Dresser & McKee Detroit, Michigan
INSPECTION DATE:	April 16, 2004
REPORT DATE:	July 12, 2004
PREPARED BY:	Michael W. Oakland, P.E. Todd W. King, P.E. Registration No. 35557 Camp Dresser & McKee One Woodward Avenue, Suite 1500 Detroit, Michigan 48226 Tel: (313) 963-1313

INTRODUCTION

This report summarizes the results of a visual inspection of the Trowbridge Dam on the Kalamazoo River in Trowbridge Township, Michigan (Figure 1). The dam is being inspected as required by the Dam Safety regulations that stipulate high hazard potential dams be inspected every 3 years or 3 years following significant repairs. Repairs were made on the Trowbridge dam during the winter and spring of 2001 to temporarily stabilize the dam in the anticipation that PCB contaminated sediments would be removed within 5 years allowing the complete removal of the dam. No substantial progress has been made with respect to the removal of the sediments, and thus, for purposes of this report, it is assumed that the dam must meet the requirements of Part 315, Dam Safety, of the Natural Resources and Environmental Protection Act, 1994 PA 451. This report is limited to a visual investigation and review of previous inspection reports, plans, and data which are available. This report should not be considered as an in depth engineering investigation.

The visual inspection was made by Michael Oakland, Stephen Amrein and Todd King of Camp Dresser & McKee. Paul Bucholtz (Michigan Department of Environmental Quality), James Hayes (Dam Safety Unit for the Michigan Department of Environmental Quality) and John Lerg, Scott Hanshue, Tyson Edwards and Sara Schaefer (Department of Natural Resources) were also present. Conditions during the time of the visit were sunny with temperatures around 60 degrees Fahrenheit. The water level at the dam was relatively low with about 6 inches of water flowing over the spillway. The flow of water obscured the spillway surface and downstream apron.

CONCLUSIONS AND RECOMMENDATIONS

The Trowbridge Dam is in very poor condition and has inadequate spillway capacity. The downstream apron of the dam and its training walls have largely broken away. A large sinkhole formed at the toe of the remaining spillway apron was filled with riprap as a temporary measure to dissipate energy, however continued erosion is possible and this should not be considered to be a permanent solution (see site sketches and photographs, Appendices A and B, respectively). While not observable on this visit, a hole broken into the spillway by a falling log or rock was previously observed. This suspected hole, while not penetrating the spillway, does create the potential for further accelerated deterioration. Also recently observed during higher pool levels is a sinkhole/seepage path on top of the dam . Dye poured into the sinkhole was seen exiting directly below the right training wall foundation indicating potential for undermining of the wall. The dam has inadequate slope protection on the upstream face which has resulted in recent sloughing on the upstream slope of the left embankment. While some patching was undertaken on the right training wall, the concrete continues to deteriorate in other areas where rough surfaces from the former partial demolition are exposed. Failure of the dam would have potential severe environmental impacts as contamination currently isolated in impoundment sediments would be mobilized and transported downstream.

If the Trowbridge Dam is not to be removed in the very near future, the following recommended repairs should be completed as soon as possible. These repairs are listed by priority.

- Reconstruct the downstream portion of the spillway including the entire downstream apron which as broken off. Repair and underpin or entirely replace the spillway as required to provide adequate foundation support, patch deteriorated concrete and fix the hole recently created in the spillway ogee section. Replace missing sections of training wall upstream of spillway to avoid erosion of embankment.

- As part of the reconstruction, the new spillway should be enlarged (raised or widened) to meet the current capacity requirements for the design storm.

- Further investigate and grout or otherwise cut off seepage through the dam including the sinkhole/seepage path which exits below the right training wall foundation and seepage through the former penstocks and powerhouse.

- The entire left and right embankments should be re-graded, removing all trees and brush, and shaped with an even crest with upstream and downstream slopes no steeper than 3 horizontal to 1 vertical. The upstream slope of the re-graded spillway should be protected by riprap with grass planted over the remainder of the spillway. Additional slope protection should be provided on the downstream slopes in the range of potential backwater levels against the dam.

- Fill all erosion paths on the upstream and downstream areas of the embankment and abutments and vegetate with grasses.

- Fill around edges of grouted riprap and patch or seal cracks in riprap surface. Provide additional riprap at downstream edge of grouted riprap to avoid further loss of riprap.

- Provide gravel or other surface protection in parking area on top of left embankment.

PROJECT INFORMATION SECTION

The Trowbridge Dam and associated powerhouse were constructed in 1899 as part of a hydroelectric facility. In about 1965, the dam was decommissioned as a power generator and ownership of the dam was transferred from Consumers Power Company to the Michigan Department of Natural Resources (DNR) in 1967. The DNR raised and jammed the spillway control gates in the open position at that time to lower the upstream impoundment to the fixed weir level. In 1986, DNR removed the taintor gates and portions of the spillway above the fixed crest. Spillway abutment walls and the powerhouse were removed to an elevation approximately 10 feet above the crest of the spillway weir. At the same time, the embankment slopes adjacent to the spillway and powerhouse were cut back to an approximate 4 horizontal to 1 vertical slope.

The dam is approximately 385 feet long. Looking downstream, the dam is comprised of an earthen embankment to the far left, the former taintor gates, the former concrete hydroelectric generation section, and the former transformer house at the right abutment. The section lengths are approximately 180, 80, 90, and 35 feet long respectively. The elevation datum used on the plans illustrating the partial demolition of the dam is not known, but it appears that a local datum of elevation (El.) 80 is approximately 680 feet using the National Geologic Vertical Datum (NGVD) (formerly the U.S.G.S. datum). Elevations mentioned in this report will be based on the datum shown on the demolition sheet.

No design drawings are available for the Trowbridge Dam. However, a limited amount of design information has been sketched onto the drawing used for the previous demolition work. Based on this drawing and descriptions in previous inspection reports and observations made during our site visit, the dam originally consisted of the following:

- A service spillway consisting of three 24 feet wide lift gates with 4 feet concrete buttresses between the gates. The sill of the taintor gates was set at El. 54.5. The original buttress between the lift gates had a top at El.71.25. Approximately 50 feet of concrete apron existed behind the sills. The top of the apron was at El. 48.25 with a bottom of the sill and apron at El. 45. The sill and apron are believed to be founded on the glacial deposits which underlie the area. An abutment wall was constructed on both sides of the spillway. The abutment wall on the left side was approximately 3 feet thick and bent to the left at the end of the buttress for the taintor gates, allowing the downstream apron to fan outward. The wall on the right side was part of the powerhouse and was about 6 feet thick. The wall originally extended as a straight wall 58 feet downstream from the end of the buttress which was approximately 35 feet beyond the end of the spillway apron. The top of the right abutment wall was at El. 58.0.

- A powerhouse to the immediate right of the spillway was approximately 90 feet by 35 feet in plan dimensions and had a top at El. 71.25 with a lowest level at El. 34.0. The powerhouse included three turbines with grates and raceways to each turbine. The powerhouse was founded in the glacial deposits which underlie the area. A near vertical concrete foundation wall formed the downstream side of the dam with the discharge below the water level.

- A generator building which measured approximately 35 feet by 50 feet in plan dimensions existed on the right abutment of the dam. No details of the building are available.

- A left embankment consisted of an earthen embankment up to about 35 feet in height with a crest at about El. 80. The embankment had a crest width of at least 50 feet with relatively flat upstream slopes and approximately 2 horizontal to 1 vertical downstream slope. The embankment is currently grass covered with some saplings and brush.

PRIOR INSPECTIONS

As part of the 1986 demolition, a large portion of the powerhouse has been removed along with the spillway walls and buttresses to just above the level of the fixed spillway at about El. 60.5. A low area remains where the powerhouse existed with slopes of about 4 horizontal to 1 vertical extending upward from the removed powerhouse and left spillway abutment wall. During 1998 some cobbles and small boulders were placed over the downstream cut area on the left abutment as erosion protection.

Since the 1986 demolition, the dam has been inspected by the Dam Safety Unit in September 1993, August 1994 and September 1996. The 1996 inspection report by the DNR contained the following observations:

- The end of the left downstream abutment wall is cracked and separated by several inches. Water flowing through the crack is eroding the downstream embankment toe. The cobble and boulder riprap noted above was placed as a result of this erosion.
- Additional erosion of at the toe of the left embankment is occurring about midpoint between the spillway and abutment.
- Brush is growing within the embankment and along the crest of the remaining powerhouse foundation which is intended to act as an auxiliary spillway.
- Seepage is flowing from below the riprapped toe below the powerhouse foundation. However, the seepage is suspected to be through the turbine chamber rather than below the foundation.

The dam was inspected again in November 1998 by CDM for purposes of assessing interim repairs required to maintain the stability of the dam over the next 5 to 10 years during removal of PCB contaminated sediments upstream of the dam to allow for the dam removal. The inspection recommended that the large erosion hole downstream of the remaining apron be filled with large riprap to act as an energy dissipater to avoid further erosion, the heavily spalled concrete of the right training wall be patched, grouted riprap on the face of the downstream slope adjacent to the left training wall where severe erosion from overtopping had occurred be placed and some of the existing brush on the dam be removed. This work was completed in spring of 2001 and periodic inspections approximately every 6 months have been conducted since that time to assess the interim condition of the dams.

FIELD INSPECTION

Observations at the time of the site visit are summarized as follows:

- In general, the right embankment is uneven with a low area at the former powerhouse with demolition debris covering most of the embankment. The upstream edge is highly uneven with water forming pools in the debris as much as 15 feet into the embankment. A sinkhole/seepage path was seen on a former visit. Dye testing confirmed that it exited from below the right training wall foundation.

- Upstream portions of the right training wall are missing, causing water flow to move rapidly across the embankment on the right side.

- Upstream portions of the left training wall are missing, causing an area of the left upstream embankment to slough into the river.

- The missing training wall and low area of the embankment appears to allow overtopping behind the left training wall. Overtopping and/or surface water runoff are causing an erosion path in the upstream area and causing loss of topsoil from around the grouted riprap on the downstream side of the embankment.

- Brush and trees are present on the upstream and downstream areas of each embankment. No upstream erosion protection is present. In addition, areas of the left downstream embankment slope, where in contact with backwater pool, also require erosion protection.

- Cracks, 1/8-inch open, were observed in the grouted riprap on the left embankment. Cracks may be due to shrinkage or some movement, but appear to be stable over the last several visits.

- Parking area on top of left embankment is bare and required either grass or gravel protection.

- The area around the former powerhouse is low and continues to be an area overtopped during storm events.

- While not leaking at the time of this visit, recent visits during higher pool conditions have shown significant leakage through the embankment at the former powerhouse location. Continuing uncontrolled leakage could cause internal erosion of the embankment, ultimately leading to dam failure.

- Downstream areas of apron and training walls are broken off and missing. The large void which formed at toe of dam is filled with boulder fill as an energy dissipater. Boulder fill appears to be remaining in place.

- Erosion paths on upstream left embankment and downstream right embankment.

- Missing stones from toe of grouted riprap where grout penetration was inadequate.

It was not possible to confirm the condition of the downstream apron, stream bed below the apron or spillway buttresses. The large erosion hole that existed downstream of the dam (which was filled with boulder fill at the time of the previous repairs) likely contributed to the lateral movement and cracking of the downstream apron.

STRUCTURAL STABILITY

Given the condition of the downstream apron and presence of the large void, this area should not be considered to be stable. While the void was filled with large boulders to dissipate the energy and slow enlarging of the void, this should not be considered to be adequate for foundation support within the zone of influence of the void. In addition, in light of the seepage from below the left training wall, a void may also exist which compromises the support of the wall. This portion of the dam should also be considered as unstable until further investigations and adequate remediation are undertaken.

Continued erosion due to seepage/flow behind the training walls or through the powerhouse embankment will continue to result in sinkholes and the ground surface behind the walls should be considered unstable.

Continued deterioration of the concrete forming the piers and training walls, will also result in loss of stability of the spillway structure.

The dam embankments appear to be generally stable with no signs of displacement other than the sloughing where the training wall is missing as the left embankment. However, the area of the former powerhouse does overtop during storm events and while no significant erosion is currently visible, long term exposure to this event could cause instability of the embankment.

HYDROLOGY AND HYDRAULICS

The inspection report noted that the design discharge for the spillway is the 0.5 percent chance flood discharge of 14,300 cfs. This would result in a flood stage at about El. 65.7 at the dam which is about 5.2 feet above the top of the spillway abutments and the current embankment grade at the former powerhouse. The capacity of the spillway with a flood stage at the top of the spillway abutment walls is about 3900 cfs which is approximately equal to the estimated 10 percent flood.

Currently, each of the overflow areas has limited erosion protection consisting of vegetation cover, loose riprap and grouted riprap in the downstream area of the area behind the left training wall. This erosion protection is considered to be inadequate for the frequency of the overtoppings. The spillway capacity must be increased to the design storm condition.

OPERATION AND MAINTENANCE

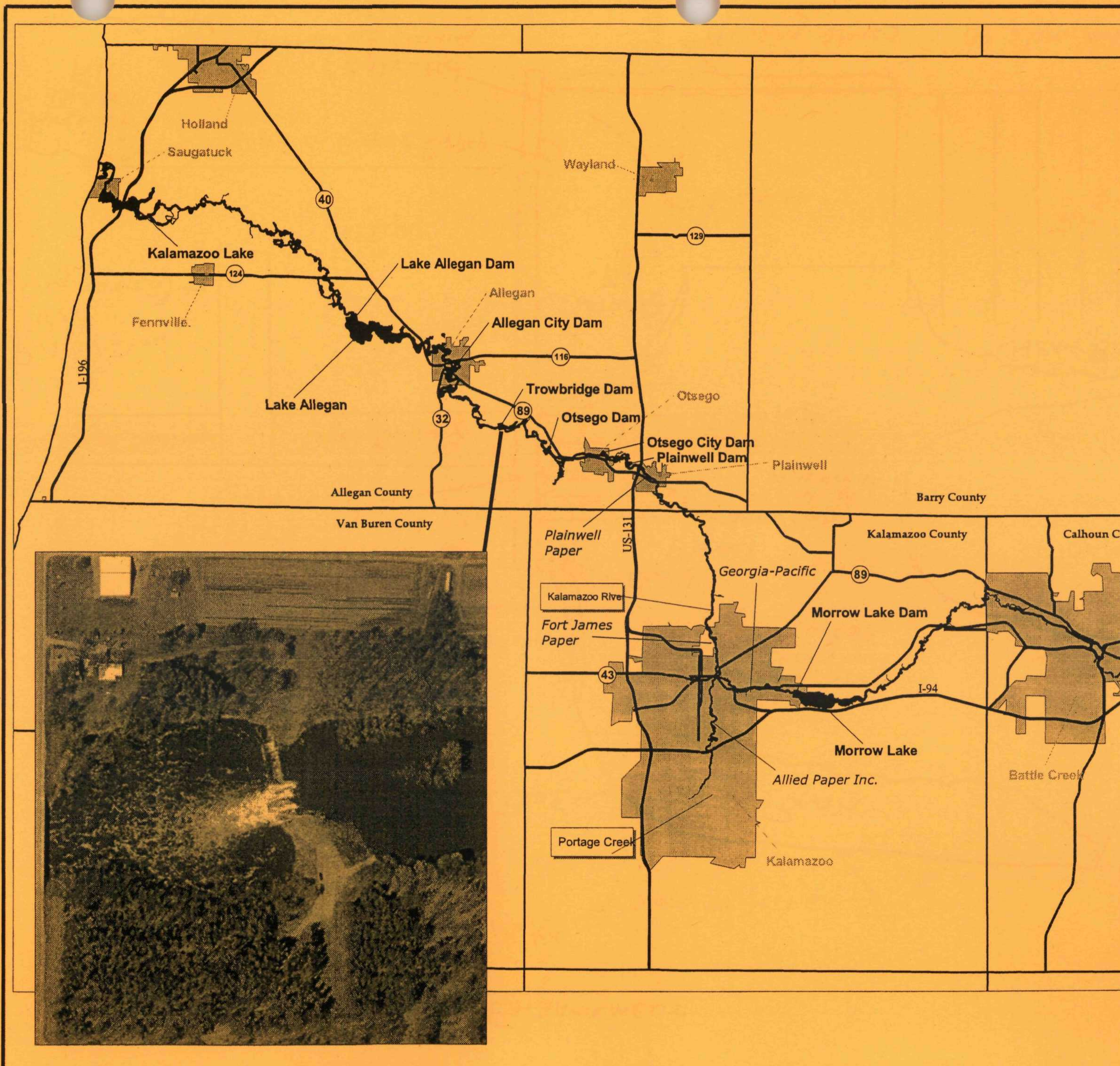
Operation of the dam is by Wildlife Division staff from the Allegan State Game Area. According to MDEQ and MDNR staff, a written operation and maintenance (O&M) plan has been developed for the dam and is on file with the Dam Safety Unit.

EMERGENCY ACTION PLAN

According to MDEQ and MDNR staff, an emergency action plan (EAP) has been prepared for this facility. A copy is on file with the Dam Safety Unit and with appropriate DNR offices. This EAP should be reviewed annually and updated as necessary.

APPENDIX

A sketch of the observations made at the time of the visit (Appendix A) and photographs from this inspection (Appendix B) are attached.



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Prepared By:
A. Santini
Updated:
6/11/04

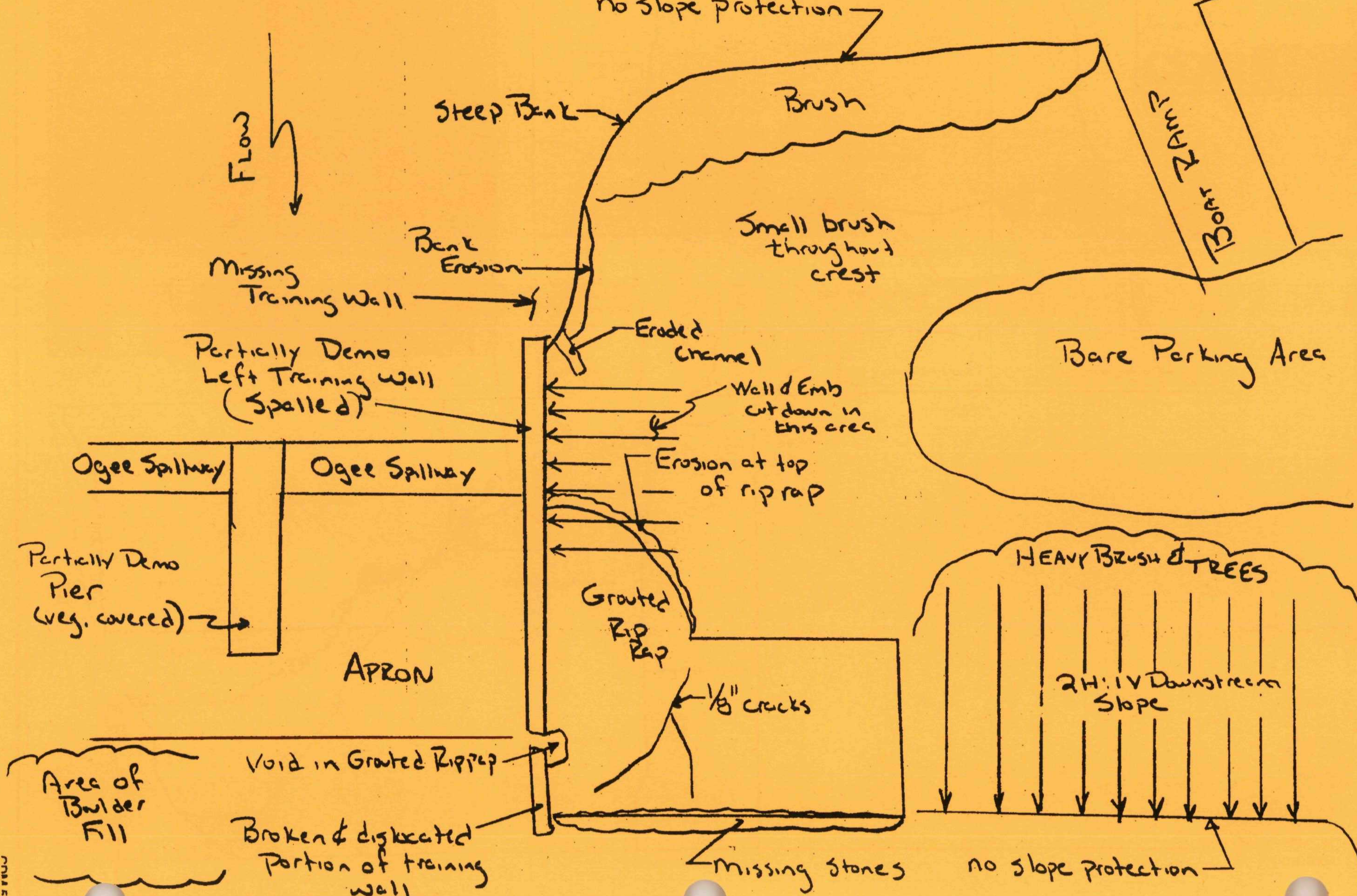
Allied Paper, Inc./Portage Creek/ Kalamazoo River Superfund Site

Overall Site Map
Trowbridge Dam

Figure No.
1

TROWBRIDGE DAM, LEFT EMBANKMENT
NOT TO SCALE

Inspection Field Sketch, 4/16/04



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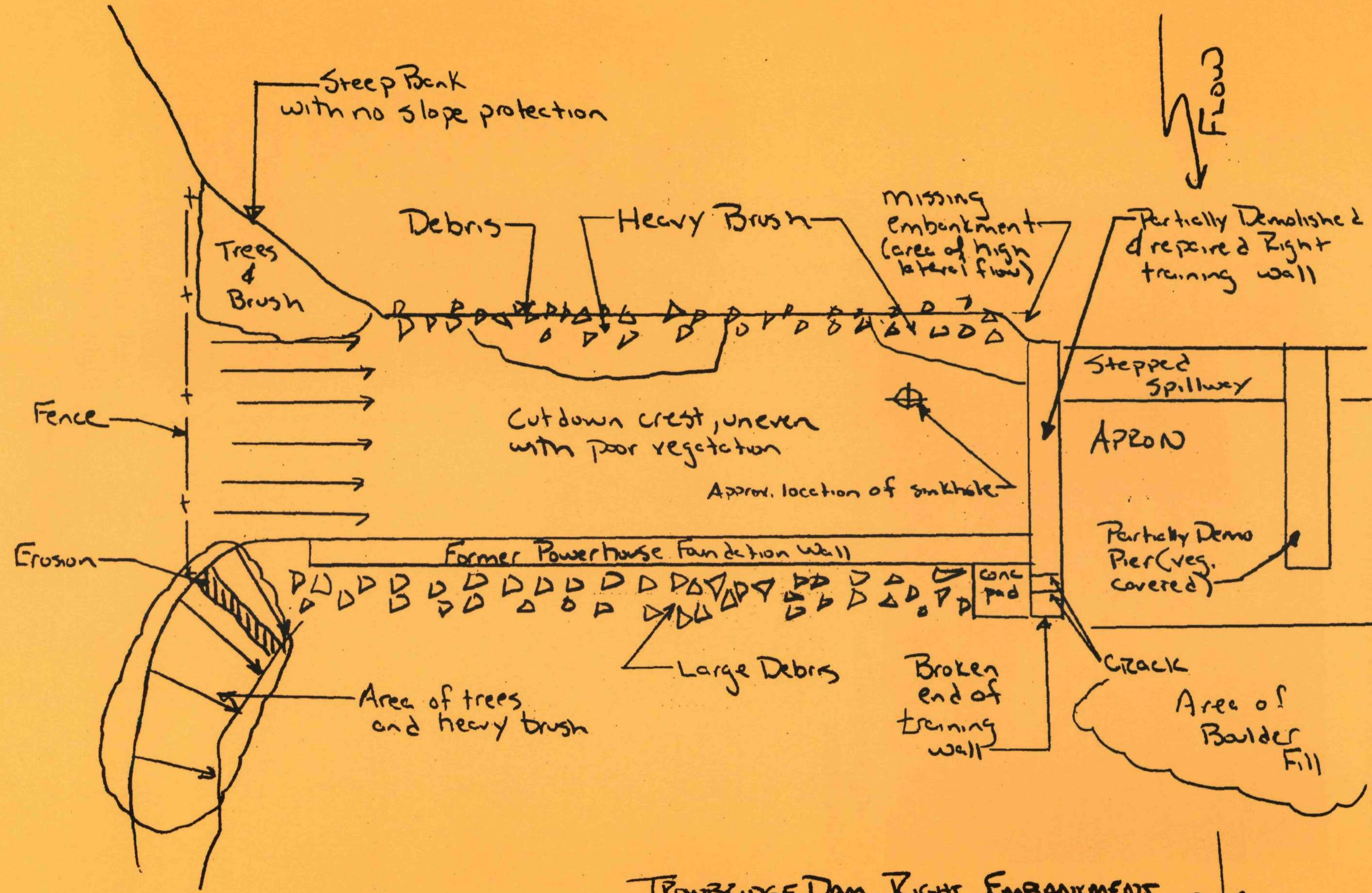
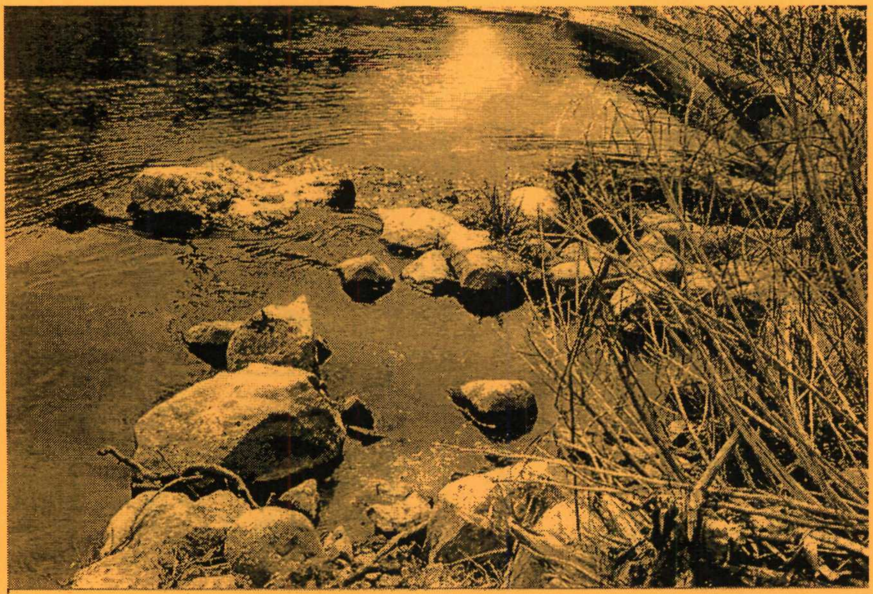


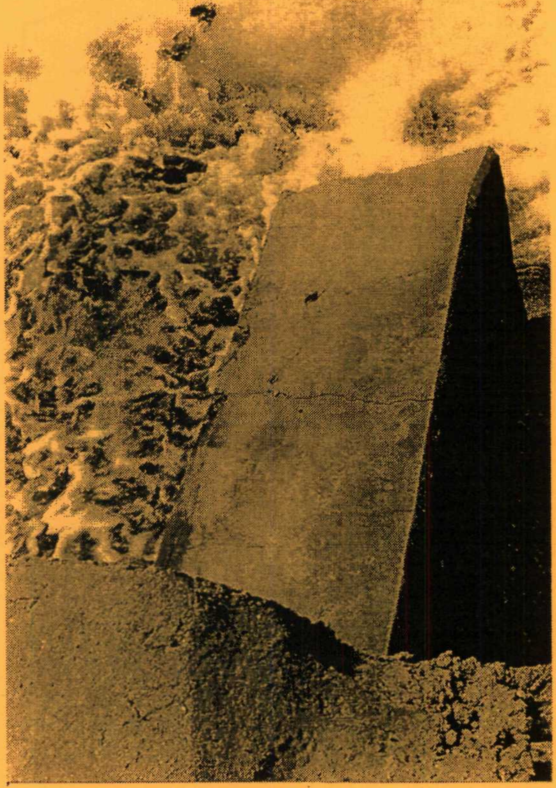
TROWBRIDGE DAM, RIGHT EMBANKMENT
NOT TO SCALE

Inspection Field Sketch, 4/16/04

Trowbridge Dam - Right Side



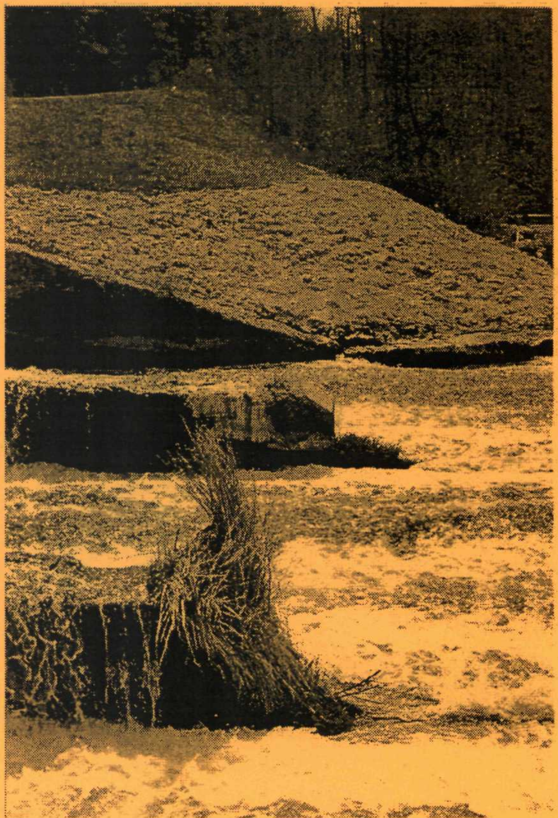
Missing Wingwall and Lateral Flow at Upstream Face of Right Embankment



Cracks in Broken Downstream Right Training Wall

Trowbridge Dam - Right Side

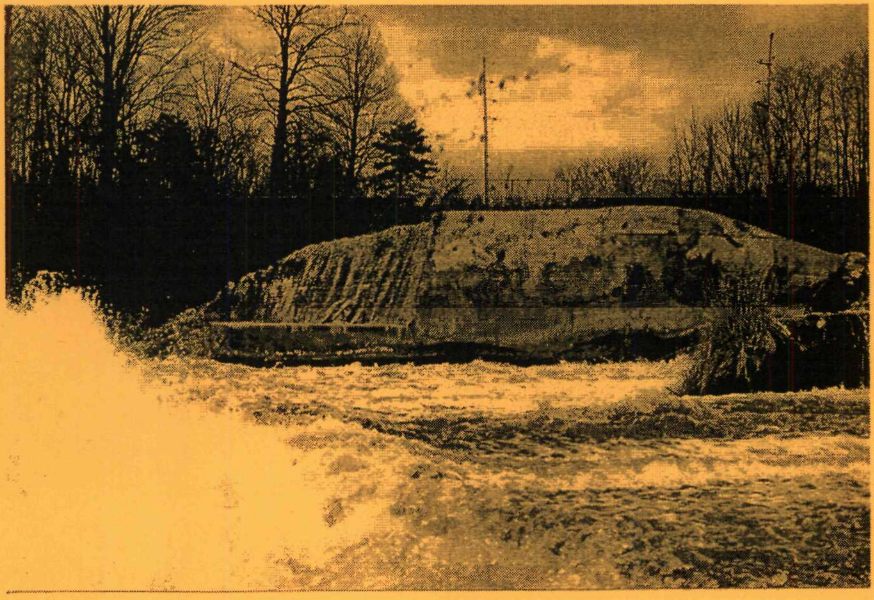
View of Sloughing Soil and Erosion at Missing Left Upstream Training Wall



View of Grouted Riprap and Broken Downstream Left Training Wall

Trowbridge Dam - Left Side

Erosion along Edge of Grouted Riprap



Repaired Right Training Wall

Water Resources of Michigan

Sediment Characteristics and Configuration within Three Dam Impoundments on the Kalamazoo River, Michigan, 2000

US Geological Survey Water-Resources Investigations Report 02-4098
Lansing, Michigan 2002

In cooperation with the Michigan Department of Environmental Quality and the U.S. Environmental Protection Agency.

By: S. J. Rheaume, C. M. Rachol, D. L. Hubbell, and Andreanne Simard

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Accessible Web version is available in Web (HTML) format at:
http://mi.water.usgs.gov/pubs/WRIR/WRIR02-4098/WRIR02-4098LW.php

Table of Contents including Figures, Tables, Appendix, Conversion Factors and Abbreviations.
http://mi.water.usgs.gov/pubs/WRIR/WRIR02-4098/WRIR02-4098TOC.php

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Abstract

The removal of the remnants of three hydroelectric dams on the Kalamazoo River near Plainwell, Otsego, and Allegan, Michigan, has been proposed. The benefits of this removal include returning the Kalamazoo River to its pre-dam flow, increasing recreational use and safety on the river, and improving aquatic habitat. The U.S. Environmental Protection Agency has designated this reach of the Kalamazoo River as a Federal Superfund site because of the historical discharge of papermill waste containing polychlorinated biphenyls. Much of this waste material remains concentrated in organic sediment and kaolinite clay deposited upstream from the three dam foundations. Sediment containing up to 150 milligrams per kilogram polychlorinated biphenyls could move if dam foundations are removed;

therefore, it is necessary to estimate the characteristic and configuration of the sediment before work begins.

Data collected from augered sections and sediment cores show that impoundment sediments were deposited in two distinctly different sedimentary environments. Interbedded lacustrine sediments that overlie the pre-dam channel surface consist of organic-rich silt and clay, fine to medium sand, and some gravel. These materials were deposited in a repetitive, cyclic fashion related to former stream velocities when the impoundment water levels were 5-10 feet higher. Lowering of these water levels and demolition of the superstructures of these dams resulted in erosion of much of these instream lacustrine sediments and subsequent deposition of coarse-grained alluvium in the impounded channel behind the remaining dam foundations.

The composite thicknesses of the lacustrine deposits and overlying alluvium was determined from sediment cores collected from each impoundment. The volume of instream sediment contained in each impoundment is estimated to be about 77,600 cubic yards at the Plainwell impoundment; 268,900 cubic yards at the Otsego impoundment; and 1,192,600 cubic yards at the Trowbridge impoundment. Estimates do not include bank or flood-plain deposits.

Citation:

Rheaume, S. J., C. M. Rachol, D. L. Hubbell and Andreanne Simard, 2002, Sediment Characteristics and Configuration within Three Dam Impoundments on the Kalamazoo River, Michigan, 2000, U.S. Geological Survey Water-Resources Investigations Report 02-4098.

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Water Resources of Michigan

Sediment Characteristics and Configuration within the Otsego City Dam Impoundment on the Kalamazoo River, Michigan, 2001-02

US Geological Survey Water-Resources Investigation Report 03-4218

Lansing, Michigan
2003

By: S.J. Rheaume, D.L. Hubbell, C.M. Rachol, A. Simard, and L.M. Fuller

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Abstract

The removal of the Otsego City Dam on the Kalamazoo River at Otsego, Mich., is under consideration by the Michigan Department of Environmental Quality and the city of Otsego. The historical discharge of papermill waste containing polychlorinated biphenyls from sources upstream from the dam has led the U.S. Environmental Protection Agency to designate the Kalamazoo River from Morrow Dam near Comstock to its mouth near Saugatuck as a Federal Superfund site. The papermill waste is concentrated in organic sediment and kaolinite clay, with the sediment containing as much as 94 milligrams per kilogram polychlorinated biphenyls. This contaminated sediment could move if the dam is removed; therefore, it is necessary to estimate the characteristics and configuration of the sediment before removal plans begin.

Data from augered sections and sediment cores show that the current Otsego City impoundment sediments were deposited in two distinctly different sedimentary environments: (1) lacustrine sediments consisting of organic-rich silt and clay, fine to medium sand, and some gravel deposited in a repetitive, cyclic fashion related to former stream velocities when the Otsego City impoundment water levels were 2-4 feet higher (1880s-1960s), and from downstream movement of lacustrine sediments during the removal of the upstream Plainwell Dam superstructure in the 1980s; and (2) more recent (1980s-2002) coarse-grained alluvium deposited on top of the lacustrine sediments. The volume of instream sediment contained within the Otsego City impoundment is estimated to be about 457,270 cubic yards. This estimate is based on the composite thicknesses of the lacustrine deposits and overlying alluvium, which were determined to contain PCBs, and does not include bank or flood-plain deposits.

Citation:

Rheaume, S.J., D.L. Hubbell, C.M. Rachol, A. Simard, and L.M. Fuller, 2003, Sediment Characteristics and Configuration within the Otsego City Dam Impoundment on the Kalamazoo River, Michigan, 2001-02, Date Posted: September 13, 2004, US Geological Survey Water-Resources Investigation Report 03-4218 [http://water.usgs.gov/pubs/wri/wrir03-4218/]

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Historical and Simulated Changes in Channel Characteristics of the Kalamazoo River, Plainwell to Otsego, Michigan

by C. M. Rachol[1], F. A. Fitzpatrick[2], and Tiffiny Rossi[1]

ABSTRACT

In a study to understand the historical effects of the construction and decommissioning of dams on the Kalamazoo River and to simulate channel changes that may result if the dams were removed, 1830s General Land Office surveys and aerial photographs from 1938, 1981, and 1999 were compared to identify historical changes in the river's planform. This analysis of the 80-mile reach from Morrow Dam to the river mouth at Saugatuck provided insight into how susceptible the river has been to channel migration. The comparison showed that changes in channel width and location were caused mainly by construction of dams and subsequent water-level adjustments in the impounded reaches upstream from the dams. Braiding also occurred downstream from one of the dams. Minor changes in channel form that were not caused by the dams, such as the development and cutoff of meander bends, were observed.

A more detailed study in a 5-mile reach, passing through the Plainwell and Otsego City dams, included compiling existing valley cross-section and longitudinal profile data into a database, assessing bank stability, and using a hydrologic model to design a hypothetical, stable channel with the dams removed. Fifty-five valley cross sections

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compiled from USGS and consultant data sets were used as a base for a bank-stability assessment and the stable channel design. The channel design involved adjusting the slope, hydraulic geometry, and flood-plain width to ensure that water could be transferred through the reach without increasing flooding or erosion problems.

The bank-stability assessment focused on conditions that are critical to failure and involved evaluating the sediment removed from the bank toe when the stage is high and calculating the factor of safety for the bank when the water table is elevated and the stage is low. Two scenarios of critical conditions were evaluated: dams present and dams removed.

Results of the bank assessments showed that, under both critical condition scenarios, the streambanks were more susceptible to toe erosion than to block failure. It also demonstrated that the locations prone to toe erosion were along the outer banks of meander bends or adjacent to bridge overpasses that constrict the river; both of which are locations where the banks are subject to higher shear stresses. As toe erosion progresses, the banks will eventually collapse as supporting material underneath is removed. Toe erosion for the dams-removed scenario resulted in higher amounts of erosion than for the dams-present scenario, leading to an overall decrease in bank stability. Effects of vegetation on the bank stability were variable; stability for some banks increased if vegetation was present, but for other banks stability remained the same.

A Pre-dam-Removal Assessment of Sediment Transport for Four Dams on the Kalamazoo River between the Cities of Plainwell and Allegan, Michigan

By Atiq U. Syed, James P. Bennett, and Cynthia M. Rachol

ABSTRACT

Four dams on the Kalamazoo River between the cities of Plainwell and Allegan, Mich., are in varying states of disrepair. The Michigan Department of Environmental Quality (MDEQ) and U.S. Environmental Protection Agency (USEPA) are considering removing these dams to restore the river channels to pre-dam conditions.

This study was initiated to identify sediment characteristics, monitor sediment transport, and predict sediment resuspension and deposition under varying hydraulic conditions. The mathematical model SEDMOD was used to simulate streamflow and sediment transport using three modeling scenarios: (1) sediment transport simulations for 730 days (Jan. 2001 to Dec. 2002), with existing dam structures, (2) sediment transport simulations based on flows from the 1947 flood at the Kalamazoo River with existing dam structures, and (3) sediment transport simulations based on flows from the 1947 flood at the Kalamazoo River with dams removed. Sediment transport simulations based on the 1947 flood hydrograph provide an estimate of sediment transport rates under maximum flow conditions. These scenarios can be used as an assessment of the sediment load that may erode from the study reach at this flow magnitude during a dam failure.

The model was calibrated using suspended sediment as a calibration parameter and root mean squared error (RMSE) as an objective function. Analyses of the calibrated model show a slight bias in the model results at flows higher than 75 m^3/s; this means

that the model-simulated suspended-sediment transport rates are higher than the observed rates; however, the overall calibrated model results show close agreement between simulated and measured values of suspended sediment.

Simulation results show that the Kalamazoo River sediment transport mechanism is in a dynamic–equilibrium state. Model results during the 730-day simulations indicate significant sediment erosion from the study reach at flow rates higher than 55 m^3/s. Similarly, significant sediment deposition occurs during low to average flows (monthly mean flows between 25.49 m^3/s and 50.97 m^3/s) after a high-flow event. If the flow continues to stay in the low to average range the system shifts towards equilibrium, resulting in a balancing effect between sediment deposition and erosion rates.

The 1947 flood-flow simulations show approximately 30,000 m^3 more instream sediments erosion for the first 21 days of the dams removed scenario than for the existing-dams scenario, with the same initial conditions for both scenarios. Application of a locally weighted regression smoothing (loess) function to simulation results of the dams removed scenario indicates a steep downtrend with high sediment transport rates during the first 21 days. In comparison, the loess curve for the existing-dams scenario shows a smooth transition of sediment transport rates in response to the change in streamflow. The high erosion rates during the dams-removed scenario are due to the absence of the dams; in contrast, the presence of dams in the existing-dams scenario helps reduce sediment erosion to some extent.

The overall results of 60-day simulations for the 1947 flood show no significant difference in total volume of eroded sediment between the two scenarios, because the dams in the study reach have low heads and no control gates. It is important to note that the existing-dams and dams-removed scenarios simulations are run for only 60 days; therefore, the simulations take into account the changes in sediment erosion and deposition rates only during that time period. Over an extended period, more erosion of instream sediments would be expected to occur if the dams are not properly removed than under the existing conditions. On the basis of model simulations, removal of dams would further lower the head in all the channels. This lowering of head could produce higher flow velocities in the study reach, which ultimately would result in accelerated erosion rates.

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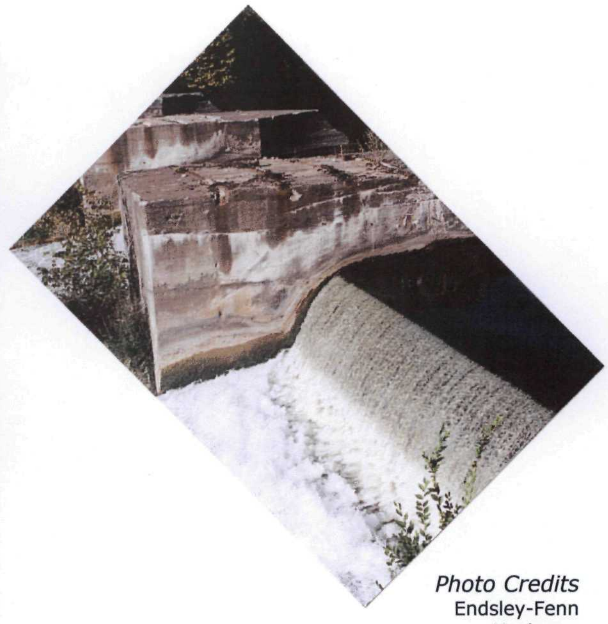

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History of the Kalamazoo River Watershed 1830 - 2004

This section is all about changes on the river between Plainwell, Otsego and Allegan.

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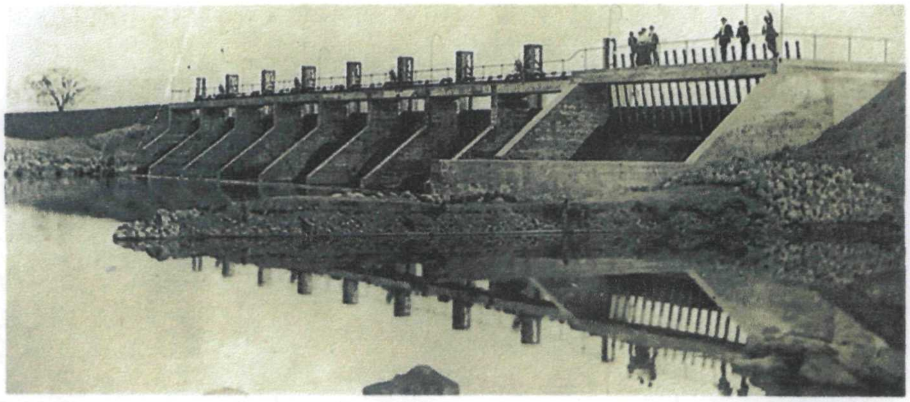
Special thanks to those helpful people at the following public libraries:
Allegan, Otsego, Plainwell, and the Kalamazoo History Room Library

Note to Dam Summit guests –

This document should be considered a work in progress. Ultimately, it will fulfill our needs for educational outreach. We would appreciate any suggestion, comments, or concerns about the content. Contact Eric at the Kalamazoo River Watershed Council, 269-327-4008 or Pat at patfenn@charter.net. Thank you.

Plainwell Dam – Then and Now
Section 1



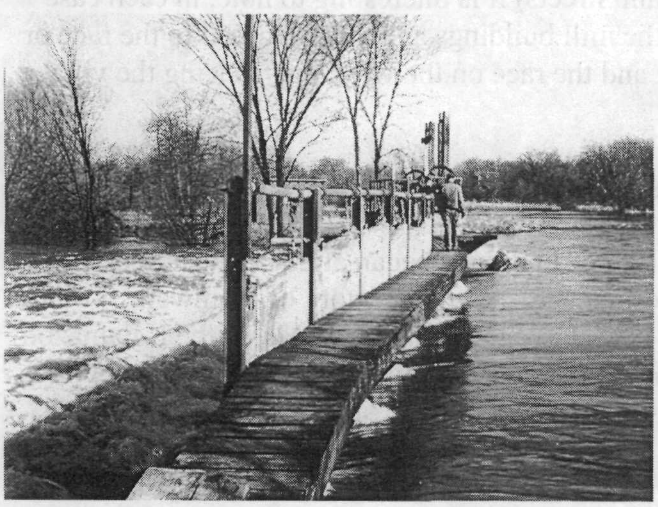
Plainwell Dam, Otsego Township, Allegan County, Michigan.

1852 - The building of the plank road to connect Plainwell to Kalamazoo and Grand Rapids, and the establishment of the Plainwell house and coach line were the foundation of Plainwell. Before this, when the first settlers came they found the land with plain fields and many oak trees or "oak openings," as described by James Fennimore Cooper when he passed this way on his search for early Indian lore up and down the Kalamazoo River. Mr. Cooper was known to have stayed at the Old Red Brick Tavern north of the village.

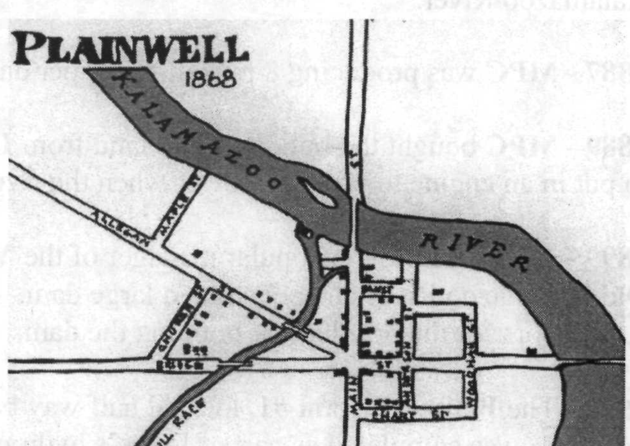
Plainwell had many names and movable centers before its present sight was named, chosen, and approved by the state. Among the many former names for the village were Dwigth, Gun Plain, New Abereen, Junction, Woodhams, and Plainfield.

The village and farm land were settled with no definite plan. One by one the settlers came to establish the shoemaker shop, the general store, the blacksmith shop, the grocery store the farms and other enterprises that did not require power.

1856 - Then big change came. The giant mill race was dug by the **Plainwell Water-Power Company** which was formed by a group of local business people, who secured the right of way to the mile and one half length of land where the race was to be dug. The race followed a natural depression of the land, a swale, across which in times of freshet in the river, the water was accustomed to run. This depression needed only deepening to nine or eleven feet to make way for the current to enter the race. The race cuts across the horseshoe bend of the river, thus making a short cut to the village. A dam was built to force the water to enter the race faster, so that the power of eight feet might be utilized.



1858 - The rake factory, grist mill, and saw mills were established on the race.



1860 - The planing mill appeared. At this time the whole township, Gun Plains, in which Plainwell is located, had a population of 587.

1863 - The village was finally plotted.

1868 - Population of the township reached almost 1000.

1869 - Plainwell was incorporated, and two rail roads were finished, roads were graded, and side walks were put down.

1870 - **Holly System** water-works was adopted in the village for fire protection.

1872 - During this year the first paper mill, **Lion & Page**, was started in Plainwell. It was located at the point where the race emptied back into the river. This was the nucleus of the giant paper mills of the future.

1873 - The **Lion & Page Paper Mill** was producing two tons of paper per day. The race was enlarged and the village became part owner of the water-power company along with the paper mill. There was a fall of 10 feet at the bulk head and a power of 8000 inches. The dam was rebuilt (probably it was extended to go across the race and river at this time) and made more substantial and safe, to better turn the whole body of river water into the race if desired, and thus placing Plainwell in the front ranks as a manufacturing center. Some of the industries, now on the race were a grist mill, saw mill, and a flour mill. The building of the race encouraged many businesses and settlers to Plainwell. Three identical iron bridges were built to cross the race. (on Allegan, Bridge, & Main Streets) It is interesting to note, in each case the water of the race was funneled through the mill buildings and then returned to the race or river. The river circled the town on the east and the race on the west, thus placing the village on an island.

1880 - There are 3,500 people in Gun Plains Township.

1886 - The **Michigan Paper Company (MPC)** of Plainwell began at 200 Allegan Street, and became the most prominent manufacturing establishment in the history of Plainwell. Twenty-five local business people founded this mill because of the cheap power from the Kalamazoo River and the connecting hydraulic race. The site and water power of the saw mill were to be used along with the handle factory site and water power.

1888 - Plainwell mill owners were fighting for the small amount of water coming down the Kalamazoo River.

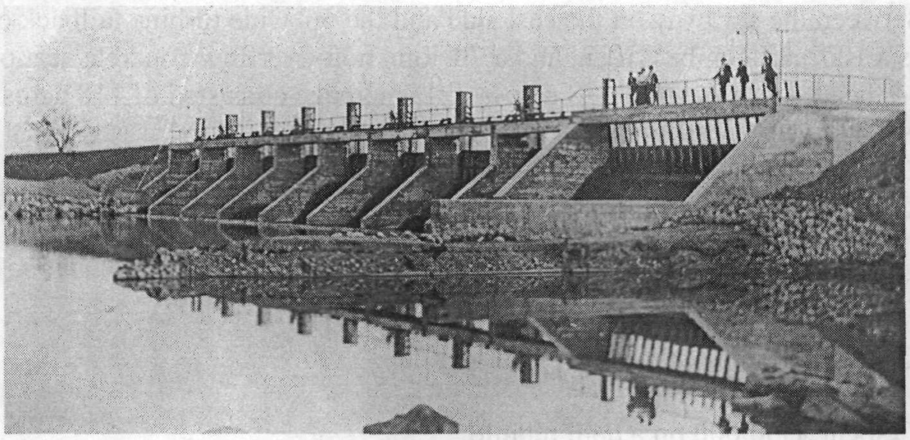
1887 - **MPC** was producing 8 tons of paper per day.

1889 - **MPC** bought the buildings and land from **Lion & Page** for $6000, and was arranging to put in an engine to produce power when the river was too low.

1899 - J.E. Botsford, the popular manager of the **MPC** of Plainwell, proposes to harness the Old Kalamazoo River and construct a large dam. He has already petitioned the board of supervisors for the privilege of building the dam.

1902 - The **Plainwell Dam #1,** located half way between Plainwell and Otsego, off 12th Street near 131, was completed as part of Foote's hydroelectric facility at the Trowbridge Dam. Plainwell's dam was first called **Commonwealth Power Company Dam,** and then

Consumer Power Company Dam (W. Foote was the founder of Consumer Power Company) operated the dam, and finally **Michigan Department of Natural Resources** became owner's of the site and took the dam to near destruction.



The dam is approximately 1215 feet long. Looking downstream, the dam is comprised of a former concrete hydroelectric generation section to the far left, a left earthen section, a concrete fixed spillway, the former lift gates, and a right earthen section. The section lengths are approximately 72, 175, 40, 176, and 750' long, respectively.

No design drawings are available for the Plainwell Dam. However, based on descriptions in previous inspection reports and observations made during site visits, it appears that the dam consisted of the following:

The service spillway consisted of eight 20' wide lift gates with an additional 40' wide ogee spillway section. A buttress was constructed between each spillway section. The top of the ogee spillway section was set at elevation 706.0 with the sill of the lift gates at El. 702.5. The original buttress between the lift gates had a top El. 715.5 and a walkway spanned the gates at El. 717.0. The spillway and sill was about 23' wide with an additional 12' of concrete apron. The top of the apron was at El. 696.5. The thickness of the concrete is not known, but is believed to be founded on the glacial deposits which underlie the area. A wall existed about 20 feet upstream of the fixed spillway parallel to the dam.

A powerhouse near the left abutment formed the left portion of the dam with the top of the structure at El. 717.0. The powerhouse included three turbines with grates and raceways to each turbine. The power house was approximately 31' wide and was founded in the glacial deposits which underlie the area. The lowest depth of the powerhouse is not known.

A retaining wall extending from the right of the powerhouse to the spillway formed the upstream face of the embankment. The top of the wall was set at El. 714.0 and the earth embankment slopes gently downstream into a former island in the river. The slope is grass covered with some saplings and bush. Larger trees exist on the former island downstream of the dam. A shallow slope also exists upstream of the wall. The height and slope of the upstream slope varies and is also grass covered.

There was an embankment on the right consisting of a long earthen embankment up to 12.5' in height with a crest at El. 715.5. A 5.5 feet high concrete wall formed the up stream side of the embankment. The embankment was constructed with a 3 horizontal to 1 vertical upstream slope and a 2 horizontal to one vertical downstream slope and a crest width of about

11'. A gravel road now exists on the embankment crest. The remaining embankment is grass covered with some small trees and brush along the embankment.

When the dam was opened it consisted of eight 20'x7' lift gates that were operated in pairs. It had three vertical shaft turbines and generators and a 40' needle stop log bay for a spillway. Between the spillway on the east side and the 66' wide turbine tailback on the west side, there is a 100' earth embankment and a 70' long non-overflow concrete section. The dam had a 13' head, and a pond of 128 acres. Total acreage consisted of 118 acres of fee land and 14 acres of flowage rights.

1906 - **MPC** was producing 15 tons of paper per day.

1909 - The water supply for the town was changed from river to wells.

1910 - **MPC** was producing 50 tons of paper per day.

1930 - **MPC** spent $350,000 on a dam rebuild.

1946 - **MPC** was producing 90 tons of paper per day.

1947 – **MPC**'s outstanding stock was bought by two Detroit news papers, **Booth News Paper** and **The Evening News Association,** to produce news print. This effort was not successful.

1954 - The former mill became the wholly owned subsidiary of **Hamilton Paper Company.** They are producing one million pounds of paper per week, that is shipped from coast to coast for such uses as catalogues, books, brochures, circulars, and business papers.

1956 - The new name was **Michigan Division of Hamilton Paper Company.** The Plainwell Mill Race had been owned jointly by the city of **Plainwell**, and the **Michigan Paper Company** and **Consumers Power Company** since 1872. Now **Consumers** has sold their 2/5th share to **Hamilton Paper Company** giving them 80% ownership. The city wants to dispose of any responsibility by selling its share for one dollar to the paper company which they refused to accept. However, they agreed to operate the race without any expense to the city.

1961 - The **Weyerhaeuser Company** began their first operations within the paper industry by acquiring the Hamilton **Paper Company**. They tried to protect the environment - established a treatment plant to protect the Kalamazoo River and a boiler addition was made in 1968 to minimize the emission of smoke and provide added steam capacity.

1965 - On December 27, the operations at Plainwell Dam were terminated.

1967 - On September 29, the dam site was deeded to the **MDNR** for recreational uses from **Consumer Power Company.** Reservations in the deed include prohibition of the use of the property for hydroelectric power generators and the erection of electric transmission lines, as well as reservation of one small parcel known as the substation site, a driveway easement and the right to erect and maintain electric lines and lay and maintain pipelines.

Water levels were maintained for a few years to encourage waterfowl production and use. However, periodic regulations of levels were necessary to reduce flood hazard.

1968 - The access trail to the Plainwell dam site was barricaded to restrict public access. The mill race was no longer used for power and the old dam located over the Kalamazoo River to direct flow into the mill race had become a hazard to river travel.

1970 – A routine strike against the **Weyerhaeuser Paper Company** by hourly workers evolved into an economic quandary for the families of the 370 employees when the firm announced on September 11, that the mill would be closed and sold. Cited as the cause was competition with new southern paper companies that could produce paper cheaper.

On November 24, Deputy Directors Sheraton and Harris approved a plan submitted by Bill Lacewood, Region III Manager, "To eliminate at once the immediate hazards of safety at the Plainwell Dam, then as funds were available to level the structures."

On December 3, **Phillip Morris, Inc.** announced that it had completed negotiations to acquire the local paper mill from **Weyerhaeuser Company**.

The Plainwell mill has been closed since last summer after the strike, when it was put up for sale.

The Plainwell paper company will operate as a division of **Nicolet Paper Company** of De Pere, Wisconsin. Nicolet is a part of **Philip Morris**.

1970 - 1971 - The water level at Plainwell dam was gradually reduced to the still level; the steel lift gates were removed except for one which still remains, and the stoplogs were removed. Apparently the large openings over the turbines were welded shut with steel, in an attempt to bar access to the public. However, vandals removed most of the protective coverings, and the buildings and dam structures were easily accessible to the public.

In the spring, Patness Salvage Company, of Holland, was contacted about possible interest in salvaging materials from the dam. They concluded that it would not be worth it.

1973 - A dam built more that 100 years ago to create the mill race in Plainwell has been giving an increasing number of canoeists a run for their lives.

In the last year one young man has been drowned and more than a half-dozen spilled into the river at the dam site, located near Gilkey School football field up river from the city.

By the time people in boats realize the dam is dangerous, it is too late for some of them to do anything and the current carries them into and over the dam.

Ownership of the dam is now split between **Nicolet Paper Co.** (80%) and the city of **Plainwell** (20%). Each would like to make a gift of their share to the other.

1974 - On May 1, U.S. Representative, Guy Vander Jagt, received notice from Otsego Township, calling his attention to the fact that, "Plainwell Dam had been extensively vandalized and was extremely hazardous to health, safety and welfare of the citizens of this nearby community."

During the period of August 19-28, the 4th Bridge Company, Force Troops, FMF, USMCR from Battle Creek used explosives to partially demolish portions of the dam in an attempt to alleviate the hazards. The efforts did not remove the hazards and certainly left some perilous conditions.

In September, a permit was issued for salvage.

1977- There was a great rebuild of the mill and it began producing 200 tons per day of very high quality paper. **Nicolet Paper Co.**

1979 - In May a National Dam Safety Inspection was made by a team of registered professional engineers from Owen Ayers and Associates, Inc., under contract with **MDNR**. The team consisted of water resources, structural, geotechnical and hydraulic engineers. Evaluation indicated that the powerhouse structure was extremely dangerous. The suggested cure was that openings should be filled in or closed, protective fences could be installed, or the foundation demolished of the Plainwell Dam.

1980 - Director's Order # WI 4-1980 prohibiting entry, except by authorized personnel to the Dam.

On August 7-8, barriers were erected in two ranks and signs were posted to deter public entry. By August 26, parts of the barrier were missing or loose and one sign was gone.

1981 - During the spring, a P.C. was submitted through Wildlife Division channels to demolish the dam during 1982-83. The proposal was approved by Division Staff and forwarded to the Executive Office.

More destruction by vandals - More fences and signs were put up. (April 15 - 30). On May 5, a request was made of the Engineers Division for assistance to evaluate the site and provide cost figures for removal of structures or eliminating safety liability hazards.

On May 11, seven signs were posted and manhole covers were secured. By May 17, all signs had been removed.

On May 20, more signs and more fencing were put up. They continued this through out the rest of the summer.

1984 - The 2nd phase of the waste treatment plant was completed at the mill.

This was the most profitable year ever for the **Plainwell Paper Company**. Profits increased 117% over 1983.

1985 - The mill became a member of the **Chesapeake family** of companies, headquartered in West Point, Va. The closing price of $209.6 million is subject to final adjustment pending outcome of an audit now in process.

1986 - The Plainwell Paper Company celebrated 100 years of paper making. The mill employed 400 at this time.

1987 - Simpson **Paper Company** bought the mill, and is headquartered in San Francisco; it is a subsidiary of **Simpson Investment Company** of Seattle, a privately owned firm, founded in 1890 as a small logging company. **Simpson Paper Company** owns 11 pulp and paper mills.

1992 - **Pfizer, Inc.** and **Simpson Plainwell Paper Company** officials broke ground June 10 next to the paper company on M89, where an on site precipitated calcium carbonate facility will manufacture a pigment used in the papermaking process.

Scheduled to go on stream in the fourth quarter of this year, the plant will pipe a slurry of PCC directly into **Simpson's** Plainwell Mill and will also supply other paper mills in the area.

Economics and the environmental benefits are driving the paper industry's switch to alkaline technology. Unlike the classic acid process, alkaline papermaking permits the substitution of PCC for wood fiber, reduces chemical consumption, is less corrosive and generates less effluent, according to Paul R. Saueracker, vice president of sales and marketing for **Pfizer**.

The Plainwell Mill has 340 employees and produces 88,000 tons a year of printing and writing papers, including recycled grades.

1997 - After more than a year on the sale block, the **Simpson Paper Company** has finally found a buyer.

The New Group Inc., an organization of five former paper industry executives who have been together for about a year, signed an agreement on March 11, to buy the mill from the Washington-based **Simpson.** The sale is expected to close within 60 days.

The group is based in LaPointe, Wis., home of company president William L. New. Each of The **New Group's** principal owners plans to move to the Kalamazoo area.

1998 - **New Group, Inc.** closed the deal to buy the mill and it became - **Plainwell, Inc.** William L. New is Chairman/CEO of the corporation.

"This gives the company a solid position with some of the largest fastest growing retailers of private label tissue paper," said New.

Plainwell Inc. now has 1,100 employees in three states and over 1.6 million square feet of manufacturing plant. The whole operation is headquartered in Plainwell.

2001 - The **MDNR** paid the **MDEQ** $66,745 to stabilize the Plainwell dam for at least a few more years when the dams should be removed. Cracks are being repaired in the walls. The idea is to make temporary repair measures to ensure the dam would not fall down.

2003 - It was announced in September that the **EPA** recently sent **MDEQ** a draft of a Feasibility Study for the first two exposed sediment impoundments on the Kalamazoo River (Plainwell and Otsego). The draft FS study included an array of seven alternatives being considered for the first two impoundments. EPA will eventually select the remedy for those impoundments from the *array* after it is finished.

2004 - In June, the public announcement of a federal plan to spend up to two years modeling cleanup options for the Kalamazoo River touched off a barrage of objections from watershed protectionists who want action, not more money spent on plans. The plans have been going on for thirty years.

2004 - The following report was made in July of this year following a visual inspection of the

Plainwell dam by contractors working with the **Michigan Department of Environmental Quality** and the **Department of Natural Resources.**

MDEQ Conclusions and Recommendations

The Plainwell Dam is in very poor condition and has inadequate spillway capacity. The dam is overgrown and has signs of erosion in several locations due to overtopping as well as inadequate slope protection on the upstream face. The concrete continues to deteriorate in the areas where rough surfaces from the former partial demolition are exposed. Failure of the dam would have potential sever environmental impacts as contamination currently isolated in impoundment sediments would be mobilized and transported downstream.

If the Plainwell Dam is not removed in the very near future, the following repairs are recommended to be made as soon as possible. These repairs are listed by priority.

Reconstruct the walls and embankment to enlarge the spillway capacity to meet current requirements. At the same time, the deteriorated concrete training walls at each side of the spillway and interior piers should be repaired and surfaces protected against further deterioration.

The entire left embankment should be e-graded, removing all trees and brush, and shaped with an even crest with upstream and down stream slopes no steeper than 3 horizontal to 1 vertical. Debris below the former powerhouse location should be excavated and replaced with low permeability fill which extend into the abetment to form an adequate cutoff to seepage. The upstream slope of the re-graded spillway should be protected by riprap with grass planted over the remainder.

The exposed right bank upstream of the spillway should be cut back and stabilized by riprap to avoid further loss of soil.

Erosion on the downstream side of the right training wall should be filled and re-graded.

Debris caught in the spillway and just upstream of the spillway should be removed.

Cut and remove brush on the left embankment near the former powerhouse.

2004 - On August 20, 2004 **Governor of Michigan, Jennifer M. Granholm**, wrote to President Bush, asking for his help with the Michigan dam's significant hazard potential, which means that their failure would likely result in loss of life, significant property damage, or serious environmental damage in the area downstream from the dams.

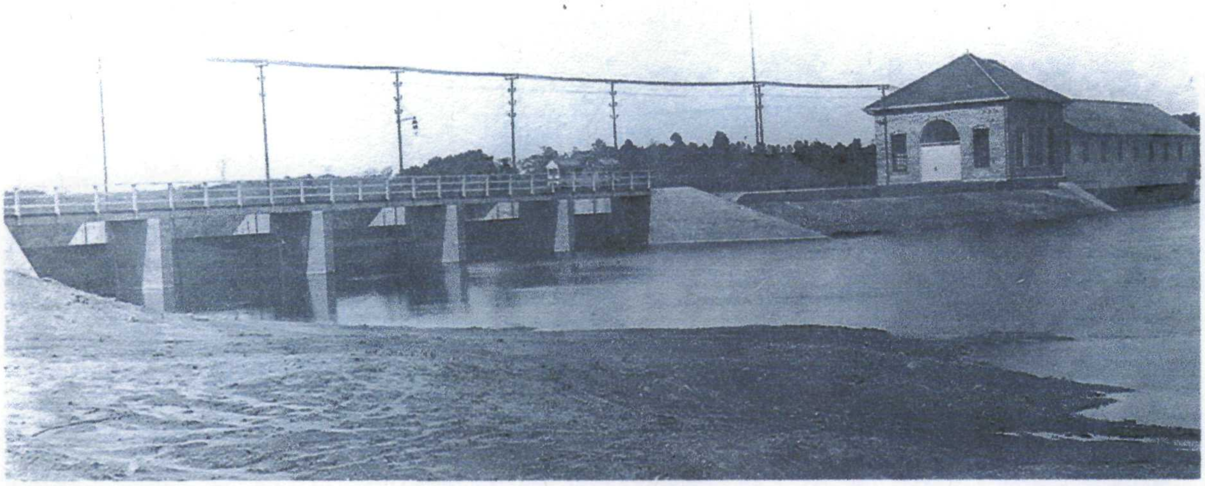
On October 20, it was announced that the city of Plainwell wants the general public to learn about the proposed redevelopment plan for the old Plainwell paper mill.

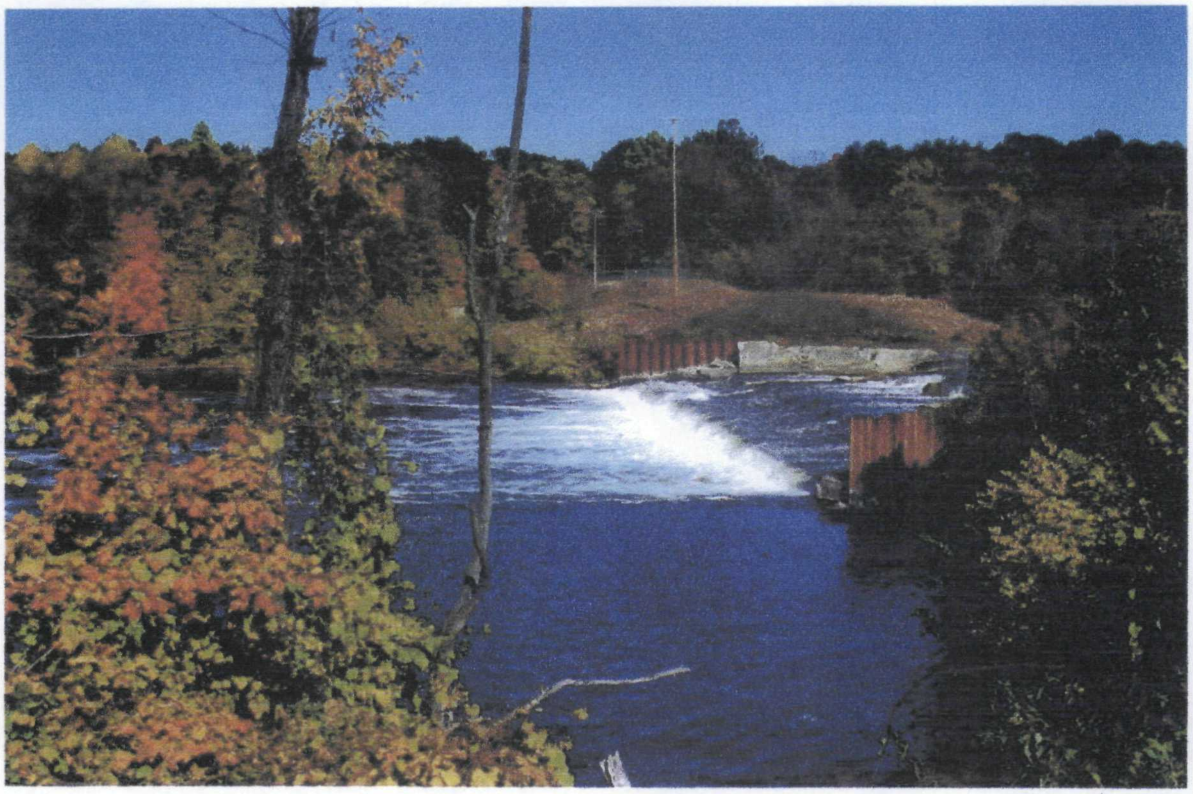
Plainwell City Manager Erik Wilson, said, "This session is about letting the public come in, take a look at where the process is at and ask questions."

The city hopes to acquire the property by paying back taxes and to recoup that investment by renting the property out in sections until a developer can be found.

Last march the **EPA** awarded a $50,000 in kind grant that allowed the city to hire **E2** to gather data about the vacant mill complex and work with a 28 member committee of residents, business owners and community leaders on ideas about how to redevelop the site.

Otsego Dam – Then and Now
Section 2





Otsego City and Township Dams, Otsego Township, Allegan County, Michigan.

The Kalamazoo River was one of the principal features of Otsego. Its power for industries went a long way in supporting the town before the days of pollution and problems. The village was situated on the rock-strewn rapids of the Kalamazoo River, immediately below its junction with Gun River and at the head of steam boat navigation. The water-power of Otsego was not surpassed by any in Michigan, having a fall of fifteen feet; the whole river was a race and required no dam.

1831-32 - Horace Hawkins Comstock, a native of Otsego County, New York, arrived in the territory of Michigan at this time, and was known as a handsome ambitious young man with lots of money.

Comstock operated largely in purchasing vast amounts of land (from the Federal Government), platting villages, erecting mills, store houses, and dwellings in a broad sweep from Detroit to Saugatuck and was well known as a very kind and generous man who gave much (and possibly all) of his fortune to those more needy.

He was married to the niece (#one of four wives) of James Fennimore Cooper, the popular novelist. They had four children before she died in 1846. He remarried when he moved to Otsego but this wife lived only one more year.

Comstock played an influential part in the development of both Kalamazoo and Allegan counties. In 1835, he was elected as the first senator of Kalamazoo County and later was elected to the State Legislative Counsel when Cooper Township was organized. Perhaps he was instrumental in naming Cooper Township after James Fennimore Cooper.

He was the founder of Comstock (upstream from Otsego just beyond Kalamazoo), where he bought a large amount of land near the mill on the river. The next season he built and supplied the general store, after that he constructed a school house, asking that they would call the village and township Comstock. He built a house here too and called it Brookside. The house still stands near the corner of Brookview and East Michigan Avenue.

He did much for the town of Comstock, and hoped to make it the county seat, likewise in Otsego, but this did not happen.

Later after he left Otsego Comstock moved back to Cooperstown where he married a third time. This wife died during a trip to Ossing, New York. Comstock then moved to Ossing and began teaching there. He died in 1861, at the age of 54. He left an estate of only $1000 and married a fourth time before he died.

1835 - Comstock early contemplated using the magnificent water-power afforded by the Kalamazoo, and because of that established the village he named Otsego. Through his influence the Otsego post office was established, and it seems that the post office came first and then the village. To put his plan into action he obtained the enactment of the following law:

Section 1. Be enacted by the legislative Council of the Territory of Michigan, that Horace H. Comstock and his heirs and assigns be and are here by authorized to build a dam across the Kalamazoo River at Otsego, in the county of Allegan.

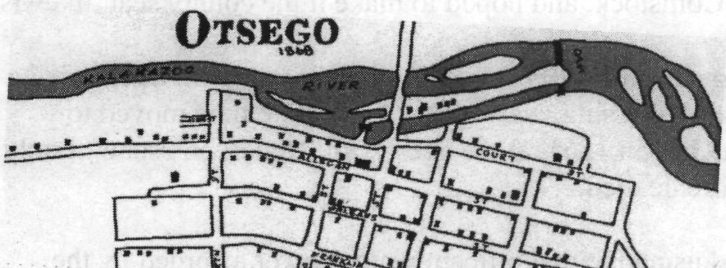
Section 2. The said dam shall not exceed five feet in height above common low water, and shall contain a convenient lock for the passage of boats, barges, canoes, rafts, or other water craft, not less than 75 feet in length and 14 feet wide in with, and shall be so constructed as to receive boats in slack water of sufficient depth below the ripple, and pass them to slack water above the ripple, for all purposes of navigation on said river.

Section 3. It shall be the duty of the owners of said dam, at all times, after the building of the same shall have been so far prosecuted as to obstruct the navigation of said river, to keep said lock in repair, and to pass any water craft or raft which can be admitted therein through the same without any unnecessary delay, free of all toll; and the said owners of said dam shall be liable to the owner or master of any water craft or raft, in double the amount of such damage such owner or master may sustain from any unnecessary detention of said water craft or raft at said lock, to be recovered, with cost of suit, before any court having competent jurisdiction.

Section 4. Any person who shall destroy or in any wise injure said lock of dam shall be deemed to have committed a trespass upon the owners thereof, and liable accordingly; and any person who shall willfully maliciously destroy or injure the said lock or dam shall be deemed guilty of a misdemeanor, and on conviction be punishable by fine or imprisonment, in discretion of the court; Provided, The imprisonment shall not exceed three months.

Section 5. Nothing herein contained shall authorize the individual named in the first section of this act, or his heirs or assigns, to enter upon or flow the lands of any person without the consent of such person; and the Legislature may at any time so alter or amend this act to provide for the further improvement of the navigation of the said Kalamazoo River.

1836 - The **Otsego City Dam** was erected and largely financed by James Fennimore Cooper, but was known at the time as Comstock's dam. Several races were built at the same time as the dam. The main race (12 to 14 feet deep) started at the south side of the dam, just west of Jewell St. and continued west until and it emptied back into the river just east of North St. (The race was filled in later and today the area is mostly park land.) None but men and older boys swam in the race and on the mill pond above the dam there were a few row boats available to rent.



Comstock's dam lowered the river's level at Pine Creek and adversely affected the water supply of the creek. The people of Pine Creek tried to dig a channel to bring the water from the river to their creek, but when they came to a hill too difficult to cut through with tools of the time they had to give up.

Fishing in the river was the best in the spring. It was then that the run of spawning fish came up from Lake Michigan and at its peak the water below the dam would seem alive with fish. The local fishermen would use dip nets to catch red horse, black suckers, pickerel, or northern pike. Only dip nets were permitted, they were huge square nets mounted on a long poll strung between two posts. The once plentiful sturgeon were stopped from migrating up the river by the Allegan Dam.

During this year the North Farmer Street Bridge was built, a small wooden structure. Later, in **1890**, it was replaced with a steel Structure. Then, again it was improved in **1903**. A cement bridge was installed in **1938** and still more in recent years.

1837 - The first grist mill was built between the race and the river.

1865 - Otsego was incorporated as a village.

1870 - The last steam boat went down the river past Otsego to Lake Michigan. Above the city dam there were at least two steam boats carrying passengers. One was a thirty footer and could carry 25 passengers. It continued to operate until the late **1890s**.

1880 - Otsego had reached the 1000 mark in population

1881 - A foot bridge was built to the small island in the river, after the dam, just before the North Farmer Street Bridge. This was to create Otsego's famous Island Park.

1887 - The first paper mill, **Bardeen No.1** went into operation on the river. At the turn of the century they were the leading employers in town. **The Berdeen Mill No. 3** began in **1898**. It burned in **1917**. These mills were located where the **Menasha Corporation** is today, west of the dam and just north of the river. In **1891, Berdeen Mill No. 2** was built on the west side of North Farmer St., between the river and the race. It was torn down in **1934-35.**

1898 - Many Otsego people were involved with building the Trowbridge Dam.

1902 - The Plainwell Dam, between Otsego and Plainwell, was completed.

1903-1904 - The **Otsego Dam** was constructed. In the early days it was called the Pine Creek Dam by the people of Allegan, as it was built just after Pine Creek enters the Kalamazoo River, and it was called the power dam by the people of Otsego as they already had the Otsego City Dam. It was constructed as part of the Footes' Trowbridge Dam hydroelectric facility downstream. The Foote brothers, (W.A. and J.B.) were pioneers in high voltage transmission of electric power. Their developments laid the foundation for the **Consumer Power Company**.

The dam is approximately 700 feet long. Looking downstream, it is comprised of a left earthen section, a former concrete service spillway, a center earthen section, a former concrete hydroelectric generation section, and a right earthen section. The sections' lengths are approximately 170, 128, 135, 110, and 157 feet long respectively. The elevation datum used in 1903 design plans is unknown but local datum of elevation of 90 is around 690 feet above the National Geodetic Vertical Datum.

The design plans show the earth embankment sections to have a crest at elevation 88.00. The crest is 16 feet for the right and center embankments and 20 feet for the left embankment. The upstream slope of the embankment is 2.5:1 while the downstream slope is 2.1. An 18 foot high plain concrete core wall extends along the earthen sections parallel to and approximately 16.5 feet upstream from the centerline of the embankment. The base of the concrete core wall is at El. 69.00 with six inch timber sheeting extending the cut off down to about El. 53.00.

The service spillway has a clear opening of 118 feet. It was originally divided into five 20ft wide bays with 4.5 feet wide buttresses between each bay. The concrete buttresses have a top elevation of and extended from 2.5 feet in front of the spillway foundation to 18" down stream of the front face of the sill. Both the front and rear end of the buttresses were beveled to form 2.5 and 3' points, respectively. The buttresses have been removed down to or below the level of the weir. The downstream portion of the buttresses has been removed to a level where they are no longer visible above a one foot depth of water. Each of the five bays had a 12.5' high taintor gate which sealed against the top of a 3.5' high tainer gate which sealed against the top of a 3.5' wide broad crested weir. The weir has sloping upstream and downstream faces. The top of the weir is at El. 71.80. It has a base width of 10.5' and is monolithic with 18' downstream plain concrete apron. The top of the apron is at El. 69.00. A six inch high, 2' wide concrete sill starts 11.75' from the weir. Oak piles on a 5' spacing along the centerline of the spillway and approximately 7' spacing along the centerline of the dam supported the weir and apron. Two piles in each of the last three rows in each bay were allowed to project 2.8' above the apron, apparently to serve as baffle blocks. The projecting portion of the piles have been removed or worn away as they are not visible in one foot of water. Six inch timbre sheet piling approximately 16' deep was to be constructed at the upstream face of the weir and a similar sheet pile cutoff wall 26' deep was planned 3.5' upstream from the end apron.

A pile supported timber grid fastened to a timber embedded in the apron just behind the sill extended approximately 24' at the level of the apron approximately another 24' a 14 inch lower level. Plans indicate the upper timber grid was replaced around 1917 with 23.5' long reinforced concrete apron extension supported on the original timber grid piles. There are also indications that the lower timber grid has also been replaced with a concrete apron but this has not been confirmed.

The concrete side walls are approximately 100' in length. They extend approximately 25' upstream of the weir and 70' downstream of the original spillway apron. The upstream and down stream walls are supported by a single pile line with piles approximately 6' on center. The wall at the weir and apron section is supported by a twin line of piles with the piles approximately 5 feet on center. A 6-inch sheet pile cut off is connected to the spillway upstream cutoff wall and extends to the downstream end of the side walls. The length of the sheeting is 18' between the spillway cutoff walls and 24' downstream of the spillway downstream cutoff wall. The design plans do not show a connection of the left embankment cutoff wall to the spillway and spillway abutment wall cutoff sheeting. The abutment walls were removed to approximate El. 76 in 1985.

The hydro generating section of the dam has a length of 98' between side walls and a width of approximately 33'. A concrete gravel dike was constructed along the upstream face of the section with a top at approximately El. 68.42. Timber cutoff walls were present at the upstream and downstream faces of the section. The structure and dike were supported by oak piles. A generator building was adjacent to the section on the center embankment. Pile supported plain concrete training walls extending upstream and downstream were present at each end of the hydroelectric generating section. The center and down stream portion of the walls had timber cutoff walls beneath them. The original design plans do not show definite connection between the various cutoff walls. The superstructures of these units have been removed above El. 76.4 and the debris used to fill the lower portions of the structure and to create a 2;1 upstream slope to the area and a 1.5:1 downstream slope turning the section into a quasi-rubble filled dam.

After the Otsego Power Dam was built there were several gasoline powered launches put on the river and tied up at North Farmer Street Bridge. A trip to the power dam and back was a fine excursion. Before the back water from the dam had covered the rocks, there had been rapids in the river above the dam that everyone knew as "Dead Man's Rapids."

1904 - The Kalamazoo River rose so high in the spring that it flooded much of the Island Park and a group of locals worked very faithfully to control the damage. Two transformers went into the water at the Otsego Dam, (down stream). Much of the dam was washed away, and was rebuilt in the same year.

1906 - Only Otsego continued to build paper mills on the river. At this time they had seven paper mills in operation (including facilities for manufacturing of coated paper, tissue, and wax paper). This was the year that **Mac Sim Bar** Company began operations (building 21 "company" houses for some of its new employees). It was located west of John Street, between the river and River Street. M.B. McClellan, Sam Simpson, and George Bardeen combined their mill operations to make the "**Big Mac**" or **Mac Sim Bar** .

1909 - Seven Otsego businessmen organized the **Otsego Light, Heat & Power Company** to take control of the local water power.

1910 - **Babcock Tissue Mill** took over the **Paraffin Paper Mill**, located near **Mac Sim Bar** by the rail road.

1915 - The **Babcock Tissue Mill** was taken over by **Wolverine Paper Company**. In 1919 the new company began making artificial ice.

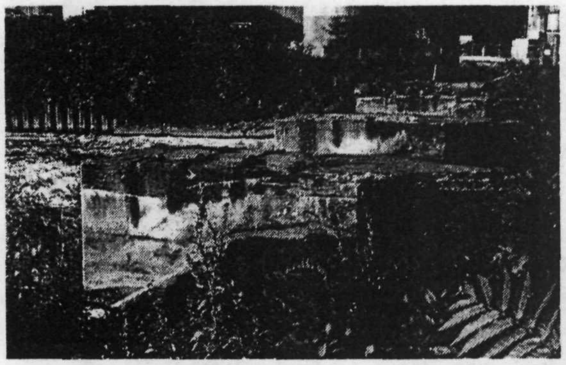
1917 - A pile-supported, reinforced concrete apron was added to the Otsego Dam's spillway.

1918 - Otsego Village became a city. William Mansfield was the first mayor.

1921 - The last of the **Bardeen Mills** and the **Coating Mill** became part of the **Allied Mills** of Kalamazoo.

1924 - The Otsego City Dam was enlarged and improved and the city used its own power for lighting the streets and pumping its water.

1925 - The Otsego Dam's powerhouse was rebuilt and new generators were installed, but it is not known if other work was performed on the dam during this period.



1934 - The third largest paper mill in the county, **Otsego Falls**, was organized in the depths of the depression. It made box board from straw for 10 years, and then converted to wood pulp in 1946. Hard wood was used for this operation.

The buildings on the property, once owned by **Bardeen Mill No.2** (shut down in 1931) were torn down to make room for the machine shop that was first used by **Otsego Falls Mill**.

1945 - The **United Biscuit** Company bought a controlling interest in the **Mac Bar Sim Mill**.

1952 - Otsego Falls Paper Mill installed a new power plant.

*All of the above mills - which, in 1907, accounted for more than 10% of the state's paper- making capacity - had spun off from Kalamazoo firms, where the industry had started in the years immediately following the Civil War. The founders of the Otsego and Plainwell companies had been employees of the Kalamazoo mills. By the mid-**1970s**, however, all of the firms, through mergers and acquisitions, had become part of large conglomerates. The **Big Mac (Mac Bar Sim)** became part of the **Mead Corporation, Otsego Falls** became **Menasha.***

1980s - The Otsego Dam and others along the river were taken down to the sills after ownership of the dams reverted to **DNR**. Because PCBs settled in the sediments behind the dams, complete removal will wait until the river is clean.

1990 – The Otsego Township Dam and The Otsego City Dam were declared part of the **Superfund Site**.

1995 - Cracks and erosion at the Otsego Township Dam are just a reminder that years are passing as the state works to resolve the PCB contamination problem in the sediments behind the dams.

Allied Paper, Inc., Georgia Pacific Corp., Simpson's Plainwell Paper Company are working with the State's new **Department of Environmental Quality** to identify the extent of pollution and the best way to clean it up.

"The water is eroding one of the two wing walls of the dam," explained Scott Cornelius, project manager for the **Superfund Section of Environmental Response**, a Division of **DEQ**.

Now the damaged portions of the Otsego Township Dam allow water to wash through and around the dam. The **DNR** must decide whether it is cost effective to repair and maintain the remains of the dams or remove them.

It's to the point now where **Superfund Wildlife** (division of **DNR**) and **Land and Water Management** are looking at long term effects. There is no way in telling how long the dam will last, but there is no apparent danger of a complete break, said Cornelius.

"It is now the opportunity for the DNR to act with the potentially responsible parties, for the clean up," said Dayle Harrison of the Kalamazoo River Protection Association.

2003 - May 19 - "It is the largest superfund site in Michigan and it may become the most expensive in the nation," according to Beard, City Manager. Beard estimates that necessary repairs to the Otsego City Dam could cost between $250,000 and $750,000. "That is more money than Otsego has," he says.

2004 - Finally, in mid-July the old **Big Mac** was shut down, the owners now being the **Rock Tenn** Company.

August 5 - The city of Otsego finds itself in financial crisis while the State of Michigan and Federal authorities decide who will clean up one of the nation's most expensive superfund sites.

The City of Otsego is required by law to make immediate repairs to the Otsego City Dam, but it first must have those plans approved by MDEQ.

"It has bled our budget dry. No matter what takes place, we will be in a major bind," said Otsego City Manager Thad Beard. "We submitted a plan to MDEQ in July - no response yet. Meanwhile, the city has to make repairs, reducing Otsego's rainy day fund's balance. It has lowered the fund from $384,000 to $118,000. This is the only capital improvement being made from our general fund."

The city finally moves to have the dam repaired at a cost of $185,000 with most of this amount covered by a gift from local paper companies.

2004 - The following report was made in July of this year by visual inspection of the Otsego Township Dam with **Michigan Department of Environmental Quality, Dam Safety Unit for the Michigan Department of Environmental Quality,** and **Department of Natural Resources.**

<u>MDEQ Conclusions and Recommendations</u>

The Otsego (Township) Dam is in very poor condition and has inadequate spillway capacity. Sinkholes continue to form along the left and right training walls of the spillway indicating sever seepage along the outside walls. The seepage is confirmed by water exiting the walls on the downstream side of the spillway. Previous undermining compromised the foundation piles on the downstream end of the training walls to the point that a portion of the wall on each side had to be replaced with a temporary sheet pile wall and it is believed that this process is continuing on the upstream portions of the dam. In addition, the lower downstream apron of the spillway is cracked and sections of the apron have recently broken off. It appears that the pile foundation support below the apron is also deteriorating. In addition, both the left and right embankments are overgrown in areas and have signs of erosion in several locations due to overtopping or excessive foot traffic. The dam has inadequate slope protection on the upstream face. The concrete continues to deteriorate in the areas where rough surfaces from the former partial demolition are exposed. Failure of the dam would have potential sever environmental impacts as contamination currently isolated in the impoundment sediments would be mobilized and transported down stream.

If the Otsego (Township) Dam is not to be removed in the very near future, the following recommended repairs should be completed as soon as possible. These repairs are listed by priority:

Reconstruct the entire spillway structure, replacing the walls, slab and fixed crest weir on a new foundation. As part of the reconstruction, the new spillway should be enlarged to meet the current capacity requirements for the design storm.

The entire left and right embankments should be re-graded, removing all trees and bush, and shaped with an even crest with upstream and downstream slopes no steeper than 3 horizontal to 1 vertical. Debris below the former relocation should be excavated and replaced with low per mobility fill which extend into the abutment to form an adequate cutoff to seepage and to avoid loss of ground into the penstocks and basement of the former structure. The upstream slope of the re-graded spillway should be protected by riprap with grass planted over the remainder of the spillway.

Allegan City Dam – Then and Now
Section 3

Allegan City Dam, Allegan Township, Allegan County, Michigan

Allegan was an establishment of invested capita and became known as a *company town*, because most of the land was owned by absentee land owners bought on speculation. The investment of eastern capital and the promotion of manufacturing and village sites in the new regions of Michigan were a favorite method of capitalistic enterprise at this prosperous period. However, this was the only town settled, on the Kalamazoo River, as a company town.

1833 - In late summer of this year George Ketchem, Stephen Vickery and Antony Cooly were the original purchasers of most of the land on which Allegan village was built.

Elisha Ely, evidently a man of means, came from Rochester, New York, late this same year. He represented other investors from the Boston Company and was a capable executive. He bought 1/3 of the land owned by Ketchem, Vickery and Cooly, and also agreed to develop the water power and build a saw mill. The next spring he turned his property and enterprises over to his son, Alexander, who thereafter figured prominently in village and county affairs. He became the president of the Bank of Allegan (owned by the Allegan Company) and owned the first news paper in Allegan County. Elisha returned to Rochester and returned with more settlers for Allegan. A considerable amount of settlers came from Rochester. E. Ely was elected the first state representative from Allegan.

1834 - A. Ely, Ketchem, Vickery and Cooly projected a village and employed Oshea Wilder to survey the plat, latter he became the president of the Bank of Singapore (Saugatuck) for its brief and inglorious existence. It was due to the irregularities in the first survey that the streets of Allegan run in such bizarre directions and with such intricate angles.

Also at the end of this year permission was given from the **Territorial Government of Michigan** to construct a dam as follows:

An act to authorize the building of a dam across the Kalamazoo River.

Sec. 1. Be it enacted by the Legislative Council of the Territory of Michigan, that ***Samuel Hubbard, Edmon Monroe, Charles C. Trowbridge, Sidney Ketchem,*** *and* ***Alexander L. Ely*** *and their heirs and assigns are hereby authorized and empowered to build a dam across the Kalamazoo River at Lion*, in the County of Allegan.*

Sec. 2. The said dam shall not exceed three feet, above common water, and shall contain a convenient lock for the passage of boats, barges, canoes, rafts or other water crafts, not less than 75 feet in length and 14 in width.

Sec. 3 It shall be the duty of the owners of said dam, to pass any water craft which can be *admitted therein through the same free of toll, without unnecessary delay: and any person who shall be unnecessarily be detained, shall be entitled to recover of said owners, double the amount of the damage which he shall prove he sustained by said detainment.*

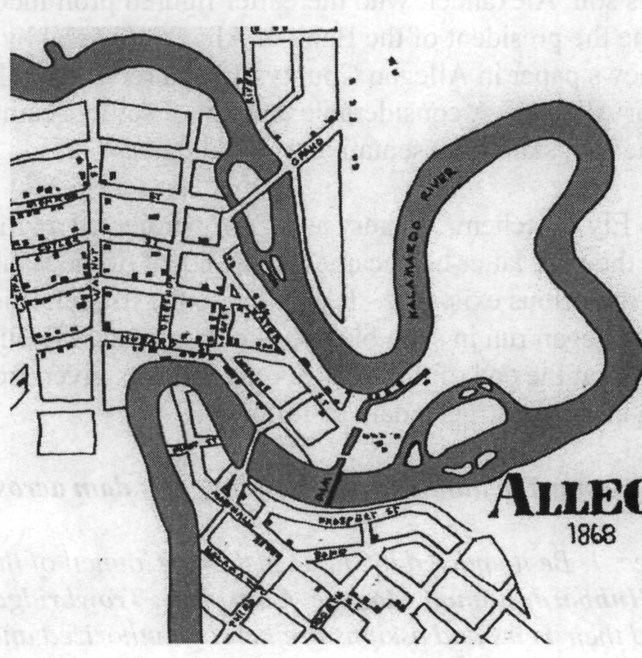
Sec. 4. Any person who shall destroy, or in any wise injure said lock or dam shall be deemed to have committed a trespass upon the owners there of, and liable accordantly, and any person who shall willfully and maliciously destroy or injure the said lock or dam, shall be deemed guilty of a misdemeanor, and on convention, be punished by a fine or imprisonment in *the discretion of the court. Provided, that the imprisonment shall not exceed the term of six months.*

Sec. 5. Nothing herein contained shall authorize the individuals named in the first section of this act, their hairs or assigns to enter upon or flow the lands of any other person, without the consent of such person: and the legislature may at any time so altar or amend this act as to provide for further improvement of navigation., of the Kalamazoo River.

**Lion was the first name for Allegan, the village.*

1835 - A temporary dam, with layers of stone and pine logs, was constructed across the river. Many changes were made over time to this first structure.

When the first people began to settle in Allegan Township, they found wall-to-wall timber. There were no natural openings for farms or villages. It was said that timber was so thick that sunlight never touched the ground. Some farms were not completely cleared for many years, the quickest way to an early crop being to girdle the trees. This would kill the them and cause the leaves to fall, allowing enough sunshine to reach the ground so that meager crops of potatoes, corn, beans and squash could be grown.



The Kalamazoo River cut across the southwest corner of the Allegan Township, and wound its way with fifteen horseshoe bends before exiting the township. This distance, as the crow flies, is two and a half miles; however because of the bends it becomes eleven miles. In the middle of the River, as it crosses this area, was found substantial rapids where the river drops eight feet in a short space. This is where the dam was built and the village of Allegan was established.

Nature had designed the site of Allegan for the village's desired purposes. The long horseshoe bend in the river, by which the swift current after flowing more than a mile from the entrance of the horseshoe is bent back to within a few hundred yards of its beginning, is an ideal situation for the development of water power and was so recognized by the founders of the village.

1836 - The whole of Allegan County had a population of less than five hundred white settlers. The settlers found that the Kalamazoo River was the boundary between the hunting grounds of the Pottawattamie and the Ottawa. The Indians were a great help to the early settlers and had already traded furs with the early established trading posts on the Kalamazoo.

1837 - F.J. Littlejohn was employed to revise the village plan and rectify the survey as best he could since many settlers were already building houses and business enterprises on the former plan.

Now comes an important change - George Ketchem, one of the original owners seems to have been an agent in introducing change in proprietorship of Allegan. He was employed by Samuel Hubbard, a resident of Boston and Judge of the Supreme Court of Massachusetts, to purchase Michigan lands. Besides buying land in his own name he was also recommending Judge Hubbard to purchase an interest in the village site. Several others were also interested in being in on the deal, including Charles C. Trowbridge.

Trowbridge, the distinguished Wayne County, Detroit, capitalist, along with Hubbard, Monroe and Pliny Cutler of Boston, purchased 2/3rds interest of the land owned by Ketchem, Cooley, Vickery, and Ely. The title rested with Judge Hubbard. Ely retained his interest but soon after surrendered his part to Trowbridge.

Thus, it comes about that Hubbard and Trowbridge are named proprietors of the village, although with the others mentioned had financial and active interest in its development. This association of men was called the **Allegan Company**. During the company's existence they furnished capital and exercised the executive control of Allegan's growth and development.

Though the **Allegan Company** must be given credit for founding the village and bringing in money and settlers to give it a fair start, so far as Allegan's permanent prosperity is concerned the company failed.

The principals in the **Allegan Company** at this same time purchased 20,000 acres of land in Allegan and surrounding counties, for the exploitation of this property, they carried on the operations under the name of the **Boston Company**.

The two companies were nominally independent though their interests were harmonious. The settlers didn't know one company from the other, which accounted for a lot of confusion. So, it became known simply as - *the company*. They even created their own bank and money, which would go down in history as one of the "wild cat" variety. It was organized by the company to take advantage of banking laws which allowed the use of land as the basis for the issuance of currency.

The company built most of the mills and hired people to run them.

1837 - The "bust" of the company and the economy began this year.

1837 - The Allegan City Dam (Factory District Dam) or (Mill District Dam) was built of timber, and grew eventually to provided enough power for eleven mills, by channeling the water through various races. Water wheels provided power from the current passing under them (under shot wheels) to the various mills. There were many small races cut out from the river to force the water to turn the wheels and then returning the water to the river.

Also, a steamboat service was established between the village and the mouth of the river (first Singapore and then Saugatuck) already carrying produce from the upper river to Lake Michigan.

1838 - The village of Allegan was incorporated. Around this time, when the whole area was in a depressed state, the company started the first "public works project." They set people to work repairing the dam and mill races, which were in very bad condition. The people were paid five dollars a day in company orders. Everyone owed the company, therefore the company orders were as good as gold, and everyone was happy for a while.

1842 - One of the last major projects of the company was the construction of the steamboat *C.C. Trowbridge* at Singapore for service on the river between Allegan and Lake Michigan.

1844 - This year marked the end of the company. With the "bust" beginning in 1837, land values fell through the floor, the Bank of Allegan's beautifully engraved money was worthless and the whole scheme in "one financial wreck, depriving the settlers of available capital save their own indomitable courage and tireless industry," according to the *History of Allegan and Barry, Counties* published in 1880.

To satisfy the demands of creditors, eastern courts took an inventory of the **Boston Company's** unsold lands - about 20,000 acres - to be divided among the surviving owners by lot. The *C.C. Trowbridge,* only made two round trips down the river before it was sold to help pay for the cost of constructing of the steamship.

1849 - The property in the village still unsold was offered at auction and the proceeds divided among the interested parties, leaving the proceeds to Charles C. Trowbridge as the sole survivor of the company.

1873 - Only three saw mills and a Brewery were the sum total of industry in the whole of Allegan Township, as published in the *Allegan County Atlas,* 1873.

1900's - Concrete was placed over the wooden structure of the dam.

1934 - There were hardly any races left on the river, they had been filled in with water or earth, but the Allegan factory district remained very much intact.

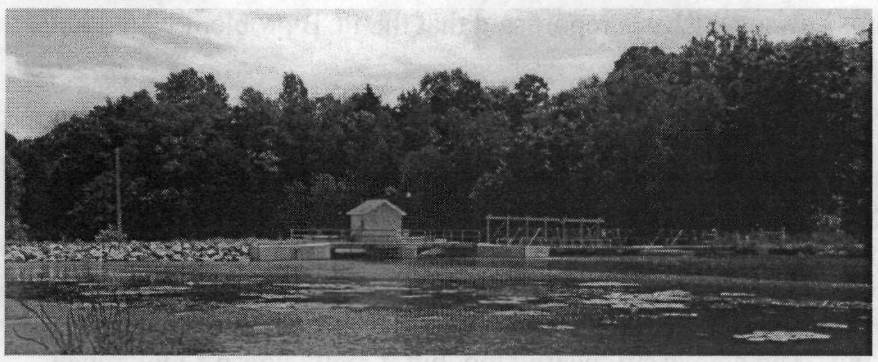
1936 - The Allegan Municipal Dam was completed in Valley Township. It was the last dam to be completed on the Kalamazoo River.

1953 - "Four acres of dead carp on the Kalamazoo" was the headline that Life Magazine put under the tremendous fish kill picture, taken in the small bay where Dumont Creek enters the Kalamazoo River. The fish had congregated there in a desperate attempt to find oxygen in the fresh water. The river itself was so polluted the water contained "zero parts per million oxygen" from Comstock to Allegan Dam in Valley Township. The early 50's brought many such incidents and the resulting public outcry marked the beginning of serous efforts to clean up the Kalamazoo River.

1979 - On June 6, Allegan City Council has established a special assessment to finance the repairs on the city dam which was washed away in last summer's flooding. The project was outlined to cost $16,240, and had already been completed. There was some discussion on who should pay for the dam repair - only one company, Imperial Carving Company, receives power from the dam. It was decided to spread the cost.

1986 - There were eighteen different industries employing 420 people, as reported on this date by the *Allegan County Promotional Alliance.*

1996 - In April, the Allegan City Council voted to purchase the Allegan City Dam. The dam owners at the time were Imperial Carving Company (75%), located adjacent to the dam, and the city (25%). The cost of the dam was about $200,000. This was to take effect in 45 days. Although the dam can generate electricity the city is mainly interested in buying it to control the level of the Kalamazoo River to protect the waterfront of the town. The dam consists of a 200 foot spillway with two gated bays and two stoplog sections with 675 feet of earth embankments 10 to 15 feet high. Earlier this month voters approved $250,000 in the sinking fund, interest money, to purchase the dam and pay for engineering studies to determine repair costs. The sinking fund was established from sales of city-owned property years ago.



In December, the Allegan City Council hired the engineering firm Fishbeck, Thompson, Carr, Huber of Ada to inspect the Dam that the city bought last month. The cost is estimated between $19,500 and $30,000. The agreement to buy includes language with a 60 day escape clause during which time the city can have consultants inspect the dam.

1999 - In June, the H&K construction company was hired to build a 120-foot temporary dam along the Kalamazoo River so that the city can repair the downtown dam's deteriorating stoplogs, which are made of planks that hold back the water. The alternative was to just lower the dam. That was shot down by MDEQ on grounds that it may stir up sediments containing PCBs.

H&K will bring in barges that will drive sheets of iron in what is known as the "needles" area of the dam. When the 8 to 9 foot deep area is clear of water, workers can remove the old wooden stoplogs and put in new ones. This was to cost $40,558.

In August, The city of Allegan is looking at $665,000 in more repairs to its downtown dam. The city had the dam inspected after H&K built the coffer dam by the Lawson Fisher Associates of South Bend, Ind., and they said, "We estimate the whole structure is 20% void". Meaning, there is nothing in the concrete in sections, the wood had disintegrated.

2000 - In May, the first phase of the project began by replacing the old aged concrete. In July, the city has again hired Lawson-Fisher Associates to assess the downtown city dam. "The study will basically be, to continue a risk assessment of the dam and propose long and short-term solutions to minimize risk," said city Manager-Clerk Robert Hillard. Some of the repairs have already been made that were suggested by the firm last May.

2001 - In January, the city council decided to ask the voters to approve $400,000 from the city's sinking fund to repair the downtown dam. This would be the final step to restore the dam which consists of grouting the voids in the spillway, repair the concrete wall, place erosion protection up stream and to raise a low portion of the embankment. This work is essential to maintain the waterfront and investments. Without such work the dam could fall. This fund is from the money invested after the sale of the power dam, years ago.

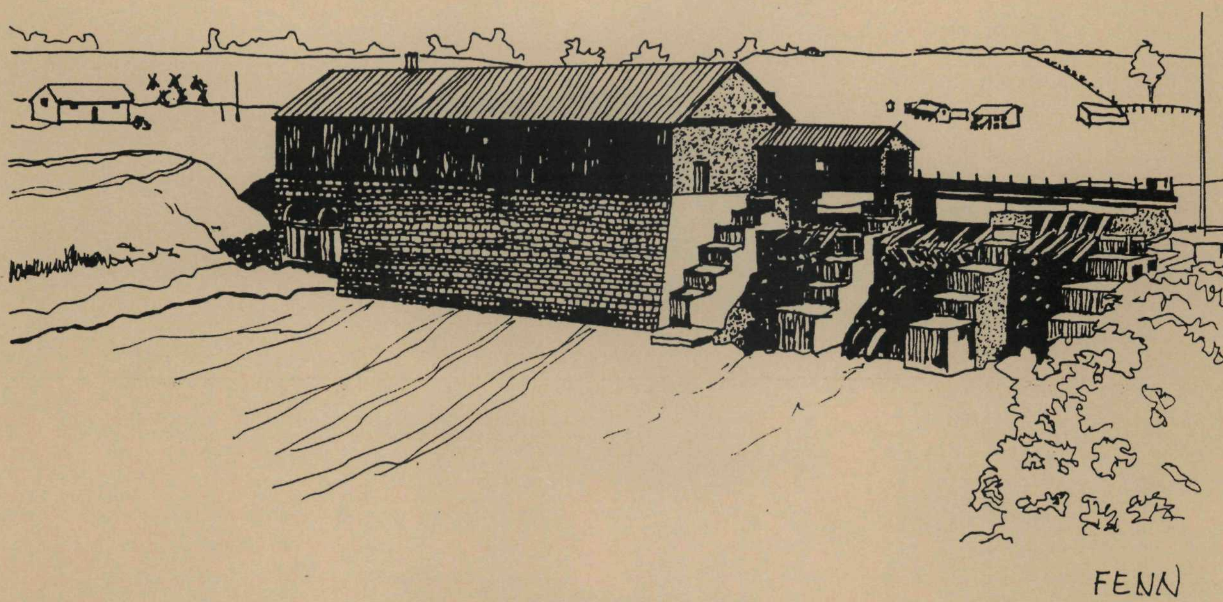
Lawson-Fisher said, "To entirely reduce the risk of dam failure, the dam would have to be removed." Also, the Michigan Department of Natural Resources long-term plan includes removal of the dam. Lawson-Fisher's report said that the PCB problem would have to be addressed before the dam removal.

2004 - The old Allegan mill district still exists, as nature begins to take possession. Most of the buildings are boarded up and some shutters are hanging out over the river from the old water wheel houses that are crumbling into the water. The dirt road travels in curves and turns from one old building to the next. There is one particularly regal two storied red brick building that stands out and reins over the others in the vacant mill district. You can still see how the race worked to power 11 mills, and one business seems to be still in operation in the old Imperial Carving building. The dam is still nearby too, but it really doesn't look much like a traditional dam.

Wouldn't it be wonderful if the whole mill district could be restored in working order for the generations to come?

The Allegan Municipal Dam is still producing power and sport when the salmon are running.

Trowbridge Dam – Then and Now
Section 4



Trowbridge Dam, Trowbridge Township, Allegan County, East of 26th Street.

1896 - While visiting Kalamazoo three entrepreneurs in electrical power, William Foote, James Foot and George Stecker took a buggy ride to Allegan. The road then paralleled the Kalamazoo River much of the way, and they stopped frequently to survey for potential water power.

Between Plainwell and Allegan the natural flow of the river drops 100 feet, a torrent by Michigan standards, and the two brothers grasped the potential right away. If they could establish a generating station and devise a way to transmit power to long distances, a feat which had never been done, they had the makings of an electrical bonanza.

They surveyed the region, and began buying up vast holdings of land and rights along the river between Plainwell and Allegan.

1898 - They chose the Trowbridge Site to begin construction on their grand designs for power. This was to be Michigan's first high voltage hydro-electric generation and transmission system and the dam was designed by the younger Foote brother, James.

Running short of funds the Footes decided to string iron wire on the wind mill poles to Kalamazoo, 24 miles away. If the experiment failed, they reasoned they could at least sell the cheaper wire for fencing. Lacking existing technology, Stickler, the project's chief engineer, had to invent a regulator to maintain a steady electric load and an oil-filled "wagon box" type high-voltage circuit breaker.

1899 - When the momentous day arrived William Foote and Stecker unleashed the pent-up power to Kalamazoo, the generators hummed, the wires cracked and a stream of electricity surged toward where James Foote stood by in the Kalamazoo plant. Then came the long agonizing wait. Finally after two hours, a messenger on horseback galloped down the dusty dam road shouting, "The lights are working!" William Foote's bold wager had paid off big.

1900 - The Company extended the Trowbridge line to Battle Creek to provide power for the new interurban train linking that city to Kalamazoo.

In the early 1900s, Charles P. Steinmetz, the German-born "Wizard of General Electric," spent considerable time conducting electrical experiments at the Trowbridge dam and the Russian Imperial Court sent engineers to study the dam.

1903 - Engineers stepped up the current from Trowbridge to 40,000 volts. By this date the Footes had already harnessed the rivers at Pine Creek (today known as Otsego Dam) and Plainwell.

1904 - The **Kalamazoo Valley Electric Company** transmitted voltage 90 miles to Jackson.

1906 - The Footes' Commonwealth Power Company controlled the electric service in Kalamazoo, Battle Creek, Albion, Jackson, and Grand Rapids.

1910 - Further consolidation yielded the Consumers Power Company, a vast conglomerate that emerged as Michigan's largest utility provider with millions of customers in both peninsulas and thousand of employees.

The Trowbridge dam was built of stone masonry construction. It had three 24' x 13'6" wooden radial tainer gates, and a pair of four horizontal twin Leffel turbines. The dam is about 200 feet long with approximately a 100 foot earthen embankment, had a 21.5' head, and a pond of 546 acres. Total acreage consisted of 660 acres. Steel tainer gates were installed in 1908.

There was a service spillway consisting of three 24 feet wide lift gates. The sill of the taintor gates was set at El. 54.5 The original buttress between the lift gates had a top at El. 71.25. Approximately 50 feet of concrete apron existed behind the sills. The top of the apron at was at El. 48.25 with a bottom of the sill and apron at El. 45. The sill and apron are believed to be founded on the glacial deposits which underlie the area. An abutment wall was constructed on both sides of the spillway. The abutment wall on the left was approximately 3 feet thick and bent to the left at the end of the buttress for the tainer gates, allowing the downstream apron to fan outward. The wall on the right side was part of the powerhouse and was 6 feet thick. The wall was originally extended as a straight wall 58 feet downstream from the end buttress which was approximately 35 feet beyond the end of the spillway apron. The top of the right wall was at El 58.0.

The powerhouse to the immediate right of the spillway was approximately 90 feet in plan dimensions and had a top El. 71, with a 90 feet by 35 feet in plan dimensions and had a top at El. 71.75 with a lowest level at El. 34.0. The powerhouse included three turbines with a lowest level at El. 34.0. The powerhouse was founded in the glacial deposits which underlie the area. A near vertical concrete foundation wall formed the downstream side of the dam with the discharge below the water level.

A generator building which measured approximately 35 feet by 50 feet in plan dimensions existed on the right abutment of the dam. No details of the building are available.

A left embankment consisted of an earthen embankment up to about 35 feet in height with a crest at about El. 80. The embankment had a crest width of at least 50 feet with relatively flat upstream slopes and approximately 2 horizontal to 1 vertical downstream slope. The embankment is currently grass covered with some saplings and brush.

1941- All surface areas of the dam were encased in concrete.

1965 - On December 27, operations at the dam were terminated. The dam site was deeded to the **MDNR** for recreational purposes from the **Consumer Power Company**. Reservations in the deed include one small land parcel known as the substation site, a driveway easement and the right to maintain electric lines.

Water levels were maintained for a few years to encourage waterfowl production and use. However, periodic regulations of levels were necessary to reduce flood hazard.

1968 - The access trails to the dam were barricaded to restrict the public.

1970 - In November, Deputy Directors Sharpton and Harris approved a plan submitted by Bill Laycock, Region III Manager, to eliminate at once all safety hazards, as rapidly as fund become available, and to level structures.

1970-1971 - The water levels were gradually reduced to sill levels, and the three steel lift gates were raised and jammed open. Openings to the dam structure itself were closed in an attempted to bar access to the public. However, vandals removed most of the protective coverings.

A salvage company was contacted to salvage the Dam. They were not interested - not worth the time.

1972 - Dore Wrecking Company, of Kawkawlin, submitted an estimate to of $11,800 to demolish the dam and the Otsego Dam.

1973 - On January 22, a letter from **District Biologist Bartels** to **Regional Wildlife Biologist** detailed safety Hazards at the dam site. During August 18-28, the **USMCR**, from Battle Creek, used explosives to partially demolish portions of the dam. Although the power house was eliminated, the dam structure itself still was in perilous condition.

1975 - On November 9, Trowbridge Bridge opened between Otsego and Allegan. The span, the only river crossing between the two towns replaces an old steel bridge, built in 1890. The work was done by H&K Construction Company at $196,206. Before starting work the company asked that the Trowbridge Dam, up stream, be put in working order to permit cutting the flow to facilitate work on the sub-structure.

The 200-foot bridge has four spans and is 32 feet across. It is 14 feet above the water. The bridge has a load limit of four ton.

1975 - 1983 - All the procedures, already noted, under these dates at the Plainwell Dam also took place here at the Trowbridge.

1981 - In November, Dave Johnson of **MDNR** says there will be a number of improvements made at the Kalamazoo River & Allegan Dam fishing sites. All of the improvements are to be paid for out of the Dingle-Johnson funds.

1983 - In October, **Allegan County officials** who advocate the restructuring of Trowbridge, and the other two dams for hydroelectric power propose a study (OK'd by MDNR) to include:

How to handle contamination and oxygen levels
Immediate issue - Safety

MDNR wanted an economic study and what value it would be for the state if fish ladders, canoe portages, and public access was establish in the area.

The Kalamazoo River Watershed Council wanted to work with **MDNR** to establish criteria or a model for restructuring.

1984 - March 2, Trowbridge Dam targeted for development as a prototype for proposed hydroelectric rejuvenation. This has been suggested by **STS** Consultants as an alternative to State funding for improving conditions on the river. They have recommended that the Trowbridge site be developed at current water levels to show that using the river for this hydroelectric is feasible. They feel because of the drop of 12 feet the dam could produce power as is. The revenues generated from the sale of electricity would be used to provide more studies on the issues which have been stumbling blocks on proposed dam renovation. The project in the end would call for all dams to be restored.

STS Consultants lists these steps:

1. Commission to agree
2. **MDNR** to agree
3. Show **MDNR** that the project would work by starting with the Trowbridge

MDNR wants more studies. Everyone wants to work together for an improved river.

1984 - Paul Zugger of the **MDNR** said that the dams are safety hazards and need to be removed next year. The plan is to shear off the dams to the sills of the structures where PCB-laden silt has accumulated.

"Results of a PBC study in 1986 will determine what the state will do about the toxic compounds carried down-stream from industries along the river. One possibility, would be a complete removable of the dams, dredging and stream bank stability. That would cost $5 million, to be paid by the state and Federal governments and private funds," Zugger said.

James Cleary, **MDNR** assistant director, said the **MDNR** was not arbitrarily opposed to the hydroelectric dam, however, and would work with the county towards a solution.

1984 - In September, James Cleary, **MDNR**, assistant director, informed Allegan county Commissioners by letter read at the meeting, that the **MDNR** "chooses not to proceed with future investments in the pilot project at Trowbridge."

The county hoped that the rehabilitation of the dam would allow fish passage, portage, public recreation access and revenues from increased generation of power.

MDNR had been providing funds for two years for the county and **STS** to conduct studies on the feasibility of the project and its potential for improving the quality of the Kalamazoo River waters.

County Commissioner Ralph Sytsma said he was surprised by the **MDNR** decision to halt the funding and go with its own plans for partial removal of the dam structures.

"Unfortunately, the project cannot ensure that hydro-electric generation at the sill elevation would improve the existing poor dissolved oxygen conditions in this reach of the Kalamazoo River." Cleary's letter said, referring to the water's ability to support fish.

1986 - November 11, **MDNR** won't budge on plans to destroy Trowbridge Dam. County Commissioner, Ralph Sytsma, said, "Despite data from a **MDNR** study and two private studies which supports the county's claim that reconstruction of the dam would not harm the Kalamazoo River they will not budge. Our interpretation of the studies shows that the PCBs will settle in the dam backwaters and be covered by silt. The plan would bring the county approximately $110,000 a year from the sale of power from the Trowbridge Dam alone. This would be enough power for 10,000 people, pollution free. It would take 28,000 barrels of oil or 6,900 tons of coal to generate the same amount of power. There is no energy crunch now, but someday it's going to come back. **MDNR** conjectured to someday remove the dams completely, and all the PCBs will erode down to the Allegan Dam. Then they will dredge the sediments there at a cost of $110 million."

The **MDNR**offic ials also dismissed the county's attempt to have the dam designated and protected as an historical structure. The Trowbridge Dam was the first of its type of structure to be built in the Midwest.

1986 - MDNR removed the tainer gates and portion of the spillway above the fixed crest. Spillway abutment walls and the powerhouse were removed to an elevation of approximately 10 feet above the crest of the spillway weir. At the same time, the embankment slopes adjacent to the spillway and power house were cut back to an approximate 4 horizontal to 1 vertical slope.

1987 - In February, while the **MDNR** mulls conditions of **Allegan County's** proposal to drop its lawsuit the **MDNR** insists that the county put up $500,000 bond until the case is settled.

The judge gave the commissioners three weeks to decide a fatal course of action.

Commissioners proposed dropping the suit and scotching their plans to develop dams along the Kalamazoo River.

In January, Judge Corsiglia granted the county an injunction to block demolition until a court could decide the issue.

On April 9th, **Allegan County** asked the Michigan Court of Appeals to decide whether it is reasonable that the county be required to post a $500,000 bond until the future of the Trowbridge Dam (also, Plainwell & Otsego Dams) is decided.

The bond was set by Circuit Court Judge Corsiglia at the time he granted an injunction preventing **MDNR**from demolishing the dams until the impact of the work had been considered by the court.

Deadline to pay the bond was the next day.

The prosecutor said, "The County is still waiting for the attorney general's office to respond to the county's offer to drop its opposition to the demolition." The proposal calls for a promise that the 100 acres around the dam will be used as a park and the **MDNR** will notify the county before working on the river.

On April 11th, the Michigan Court of Appeals ruled in favor of the County's argument for reduction of the bond required to preserve its fight for control of the dams on Kalamazoo River. Thus, the bond was reduced to $500. The county still had hopes to restore the Dams.

On April 15th, the **Allegan County** Board of Commissioners rejected a proposal from the State to settle out of court a dispute over who should control the fate of Trowbridge and the other Dams.

The county first offered to drop its opposition to the **MDNR** plan to demolish the dams. In exchange, the county asked for (1) release from liability at the dam sites, and also to have a (2) park built there and (3) notice when work was to be started.

The **MDNR** counterproposal was - (1) agreed to the notice, (2) liability and (3) to have the county help in the development of the park.

MDNR's Proposal was rejected by the commissioners. (Vote 7-6) "We want property," said Sytsma one of the commissioners. They were upset because the **MDNR** had purchased property downstream from the Trowbridge Dam on the sly. Meanwhile, the county had not paid the $500 bond and the Judge would not accept the bond money because he had not received a ruling from the appellate court.

On April 29, The County gave up its fight over control of the dams on the Kalamazoo

River. With a vote 11 to 2 the board approved an out of court agreement that could allow the county to back out of its fight to stop destruction of the dams.

On July 22, it seems **Allegan County** is not finished with **MDNR** yet. Now, they want all work on the dams to stop until they get an environmental impact statement associated with the work. **MDNR** had promised to submit that information before work began. No report has been received and work on the demolition began several weeks ago.

July 30, Trowbridge dam slowly disappears. It's demolition as usual on the Trowbridge Dam and no environmental statement in sight. The **MDNR** claims that no such agreement was in the settlement. A fisherman at the site said, "The more of this that goes on, the more difficult it will be to work together on future projects."

1990 - The Trowbridge Dam was declared a Superfund site.

1995 - Scott Cornelius, the manager of the Federal Superfund, said, " The Kalamazoo River was officially included on the national priority list for cleanup in 1980, sampling has been completed to determine the extent of pollution, but Cornelius said it may take another year before the data is released. It took 30 years to make it (the problem) and it will take 30 years to fix it."

Dayle Harrison, of the Kalamazoo River Protection Association worries, "It's possible the job will never be done."

"It was in 1978 when the KRPA became involved in the PCB issue." Harrison recalled, "Laws have allowed the state to hold paper companies and other potentially responsible for generating the problem to pay to have it fixed."

But Harrison said, "If proposed legislation is passed, polluters who caused the problem before 1987 would no longer be held responsible for damage."

A health advisory issued by **Michigan Department of Public Health** warns anglers not to eat the fish caught on the river, and because mammals and birds of prey eat fish, and because PCBs are stored in body fat, the risks to human and animal health would still remain, Harrison said.

Harrison and others also questioned whether funding cutbacks had delayed the work on the river.

"Any time you're asked to do more with less it takes longer," Cornelius replied.

2001 - Someday the State hopes to remove all vestiges of the old dams along the Kalamazoo between Plainwell and Allegan. But meanwhile those old dams hold back the polluted sediments from escaping down stream. The **MDNR** is paying **MDEQ** $233,500 to stabilize the Trowbridge for at least a few more years. The work is to be completed in February, 2001. Melbocker & Sons are repairing cracks and have filled a big hole downstream with boulders.

2004 - The following report was made in July of this year after visual inspection of the Trowbridge dam by contractors working with **Michigan Department of Environmental Quality** and the **Department of Natural Resources.**

<u>MDEQ Conclusions and Recommendations</u>

The Trowbridge dam is in very poor condition and has inadequate spillway capacity.

The downstream apron of the dam and its training walls have largely broken away. A large sinkhole formed at the toe of the remaining spillway apron was filled with riprap as a temporary measure to dissipate energy, however continued erosion is possible_and this should not be considered to be a permanent solution. A hole broken into the spillway by a rock or fallen log was observed. This hole while not penetration the spillway, does create the potential for further accelerated deterioration. Also recently observed during higher pool levels is a sinkhole/seepage path on top of the dam. Dye poured into the sinkhole was seen exiting below the right training wall. The dam has inadequate slope protection on the upstream face which has resulted in recent sloughing on the upstream slopes of the left embankment. While some patching was undertaken on the right training wall, the concrete continues to deteriorate in other areas where rough surfaces from the former partial demolition are exposed. Failure of the dam would have potential sever environmental impacts as contamination currently isolated in the impoundment sediments would be mobilized and transported down stream.

If the dam is not removed in the very near future, the following repairs are recommended and should be completed as soon as possible.

Reconstruct the downstream portion of the spillway including the entire downstream apron which is broken off. Repair and underpin or entirely replace the spillway as required to provide adequate foundation support to avoid erosion of embankment.

As part of the reconstruction the new spillway should be enlarged (raised or widened) to meet current capacity requirements for storm design.

Further investigation and grout or otherwise cut off seepage through the dam including the sinkhole/seepage through the former penstocks and powerhouse.

The entire left and right embankments should be re-graded, removing all trees and bush, and shaped with an even crest with up stream and downstream slopes no steeper than 3 horizontal to 1 vertical. The upstream slope of the re-grade spillway should be protected by riprap with grass planted over the remainder of the spillway. Additional slope protection should be provided on the downstream slops in the range of potential backwater levels against the dam.

Fill all erosion paths on the upstream and downstream areas of the embankment and abutments vegetate with grasses.

Fill around edges of grouted riprap and patch or seal cracks in riprap surfaces.

Provide additional riprap at down stream edge of grouted riprap to avoid further loss of riprap.

Provide gravel or other surface protection in parking areas on top of left embankment.

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engineers & scientists

Evaluation of Dam Removal

Appendix F – Evaluation of Dam Removal

Although removal of any of the existing dam sill structures is not a necessary component of any remedial alternative, the Michigan Department of Environmental Quality (MDEQ) has requested consideration in the Feasibility Study (FS) of an approach that would entail removing the Michigan Department of Natural Resources (MDNR)-owned sill structures at Plainwell, Otsego and Trowbridge. In response to this request, the steps that would be required to address the polychlorinated biphenyl (PCB)-containing sediments in the former impoundments, a necessary pre-cursor to the removal of the sill structures followed by the bank stabilization, soil covering, and dam sill removal components of such an alternative are presented in this appendix.

Conceptual Plan – Dredging of Submerged Sediments from the Former Impoundments, Exposed Sediment Soil Cover, Bank Stabilization and Removal of Dam Sills at the Former Impoundments with Upland Confined Disposal at Exposed Sediment Locations, Institutional Controls, and Monitoring

Description

This conceptual plan would include the removal of PCB-containing submerged sediment from the MDNR-owned former impoundment areas (Plainwell, Otsego and Trowbridge) using a series of hydraulic dredges and pumping of the dredged material to three confined disposal facilities (CDFs) located adjacent to the Kalamazoo River (one CDF in each impoundment) on top of locations where exposed sediments already contain PCB. Following construction of the CDFs, a soil cover (1 foot of sand/gravel) would be placed on all the remaining PCB-containing exposed sediments in the former impoundment areas. The conceptual plan also includes removal of what remains of lower portions of the former dams, or sills, that once impounded water in these areas. The opening of these dams caused a rapid redistribution of sediment within the river and exposed significant areas of sediment above the water line that have continued to erode back into the river over the past three decades.

Stabilization of the former impoundment banks, as described in Alternative 3 in the FS, would be implemented after dredging behind the dam sills to ensure that PCB-containing sediments from the bank areas would not continue to erode into the river. Bank stabilization activities would be implemented using an upstream to downstream approach. The institutional controls and monitoring, as discussed in Alternative 3, would also be performed as part of this conceptual plan.

As discussed in Section 4.8 of the FS, the amount of sediment that would be dredged from the Kalamazoo River is a function of the target dredging depth identified for each reach. The initial target dredging depths were estimated using the maximum depth at which PCB has been detected in sediment within each reach, plus an additional 6-inch overdepth layer. Using this approach, the initial volume or quantity of sediment that would be removed from the three former impoundments during "first-pass" dredging is approximately 1,433,000 cubic yards (cy). The gross inefficiencies associated with dredging equipment would require the removal of additional sediment below the initial target depths. The final dredging depth is thus based on the initial target depth, plus the removal of a second 6-inch overdepth layer during a final "clean up" dredging pass. The thickness of the overdepth layer (6 inches) was determined based on the smallest layer of sediment that can reasonably be removed using a small hydraulic dredge operating at close to peak efficiencies. Allowing for this overdepth dredging, which is necessary to even attempt to achieve low PCB residual concentrations, the total estimated volume of sediment to be dredged from the former impoundment areas is approximately 1,630,000 cy. The dredging depth information is summarized below on a reach-specific basis, including the anticipated depth of dredging and the resulting sediment volumes for both the first- and second-pass dredging cuts.

River Reach	Dredged Depth (in)	First-Pass Dredged Volume (cy)	Second-Pass 6-in Overdepth Volume (cy)	Total Dredged Volume (cy)
Main Street, Plainwell to Plainwell Dam	30	232,000	39,000	271,000
Otsego City Dam to Otsego Dam	18-60	495,000	64,000	560,000
Otsego Dam to Trowbridge Dam	18-42	705,000	97,000	802,000
Total (rounded)		1,433,000	200,000	1,633,000

At a production rate of 600 cy/day, and an assumption of 240 working days per calendar year, the maximum annual removal rate is 144,000 cy per year. With a total removal volume of over 1.6 million cy, applying this production rate results in a total dredging time of 11.5 years. Simultaneously dredging the three portions during the first pass could reduce the project time to five years (1.6 years for Plainwell, 3.4 years for Otsego, and 4.9 years for Trowbridge). Second-pass dredging of the Plainwell (0.3 years) and Otsego (0.5 years) portions could also be completed during this period, while second-pass dredging of the Trowbridge component (0.7 years) could be completed during the fifth year. The second-pass dredging would be implemented within each segment using an upstream to downstream approach to minimize the downstream impacts of redistribution of PCB-containing sediment that will result from dredging. Conducting the dredging and bank stabilization activities in this sequence would limit the amount of PCB-containing exposed former sediment that would enter the aquatic environment through ongoing riverbank erosion. It would also allow for the removal of PCB-containing sediment as well as any submerged erodible sediment lying below the PCB-containing sediment prior to removal of the dam sills, which would undoubtedly cause those sediments to be redistributed downstream if they were not removed first.

The dredging component would include clearing and grubbing of debris in the channel areas followed by the removal of approximately 1.6 million cy of submerged sediment with a series of hydraulic cutterhead dredges. The dredged sediment would be transported to the CDFs through pipelines that would be up to five miles in length, requiring several booster pumps to prevent the pipeline from becoming blocked. The water generated during dredging would require treatment prior to discharge back to the river. The dredging, disposal, and water treatment aspects are presented in the description of Alternative 5 (Section 4.8 of the FS).

Dredging is a technology typically used to remove large quantities of sediments from shipping lanes in waterways. The ability or technical feasibility of dredging to achieve environmental restoration objectives is highly questionable based on the results of the limited number of sediment remediation projects conducted to date. Appendix D to the FS Report presents an overview of experiences and problems encountered at other sites when applying dredging technologies to achieve target levels of risk reduction and numerical sediment cleanup goals. Dredges have been inconsistent in their ability to achieve remedial objectives, and often require two, or more, dredging passes in an attempt to do so. If the targeted dredging depths are unable to achieve cleanup criteria, additional remedial action may be necessary, consisting of additional dredging passes. This could exacerbate bank stability problems as the toes of the stream banks become lowered further.

The three CDFs and associated water treatment facilities would occupy a total area of 136 acres, ranging in size from 17 to 60 acres, as shown on Figures 1 through 3. The CDFs would be constructed with 20-foot high lined earthen berms to allow sedimentation and consolidation of sediments from the dredged material slurry. The final consolidation depth would be 16 feet at the time of closure. CDFs would be closed by placing a polyethylene liner and cap with 1 foot of sand and 2 feet of soil cover, plus a 2% graded soil cap for runoff control, as described for Alternative 5.

Overflow water from the CDFs would be treated prior to discharge back to the Kalamazoo River. The unit process operations used for treatment of the water include flocculation, sedimentation, filtration, and two-stage activated carbon adsorption. Water treatment facilities would be constructed adjacent to each of the three CDFs. The three facilities would each be designed to treat 3 million gallons per day (MGD) during first-pass dredging, with upgrading to treat 6 MGD during second-pass dredging. Treatment plant operations would also include monitoring the discharge effluent to ensure compliance with applicable standards.

The exposed sediments in the former impoundments cover approximately 510 acres (59 acres in the former Plainwell Impoundment, 77 acres in the former Otsego Impoundment, and 374 acres in the former Trowbridge Impoundment). CDFs within each exposed sediment area would cover 17 acres in the former Plainwell Impoundment, 44 acres in the former Otsego Impoundment, and 60 acres in the former Trowbridge Impoundment, leaving a total of 389 acres of exposed sediment that would be covered with a 1-foot soil cap. It should be noted that the exposed sediment currently has a well-established vegetative cover, and any PCB contributions to the river from these areas during periods of inundation are expected to be small. Generally, the exposed sediments lie within the area defined by the former impoundment water elevations when the associated dam structures were at their full height. The thickness of the former sediments ranges from several inches in the areas at the upstream end to several feet in areas near the current dam sills. The average thicknesses of the former sediments are estimated at 3.8, 4.4, and 3.1 feet within the former Plainwell, Otsego and Trowbridge Impoundments, respectively. The former sediments have the appearance of gray clay and silt. Brown to light brown and orange sand and silt native soil exists beneath the exposed sediments and at the surface at higher elevations outside the former impoundment boundaries.

Although covering all of the exposed sediments/soils in the former impoundments is not necessary to address any remedial goals for the Site, it is assumed that the soil cover placement would proceed concurrent with the bank stabilization activities. Since the exposed sediments are generally immediately adjacent to the riverbanks, the access roads and other infrastructure constructed for bank stabilization would also be used for constructing the soil cover. The placement of the soil cover would generally begin as soon as the access areas and access roads for the bank stabilization activities are constructed, and could continue throughout the winter, since construction could be easier on the frozen ground. This would allow for staging of cover materials and cover placement activities to start from the already constructed access areas and roads. About one foot of sand and gravel would be placed over the exposed sediments and existing vegetation in the former impoundments, and the surface revegetated at the end of the project by direct seeding or hydroseeding. Established trees would not be removed; soil would be placed around the trunks. These measures would be taken to maintain the existing rootmass that currently provides significant physical stability and mitigates surficial erosion of PCB-containing exposed sediments. It is expected that geotextile/geogrids would be needed for in areas where the existing soils will not support construction activities. Alternatively, it may be possible to place soil in these areas during winter over frozen ground.

Work areas for the soil cover would be isolated by the installation of silt containment systems consisting of hay bales and silt fences. In addition, a floating, marine-type curtain would be used during bank stabilization activities. In order to place the cover materials on the exposed sediments on several small islands that are present within the open water of the former impoundments, materials would be loaded into scows and transported to the work areas. Temporary staging areas would be constructed at each of these work areas. Temporary docks constructed for bank stabilization activities would be used for mooring and launching scows and barges.

During bank stabilization and soil cover placement activities, the water column would be monitored for turbidity to evaluate the effectiveness of the silt curtain. As in Alternatives 3, 4, and 5, post-implementation monitoring would be performed to assess the need for maintenance.

Following completion of the second-pass dredging, the dam sills at the three former impoundments would be removed. Removal of the dam sills would be the last step in the construction process since water levels would be lowered by five to ten feet; this would potentially complicate dredging efforts and would lead to the release of PCB-containing sediment if dredging were not completed prior to sill removal. Construction activities to remove the dam sills would include use of a hydraulic hammer attached to a backhoe or other heavy machinery. Removals would be conducted in increments to prevent sudden release of remaining sediments behind the dam sills. The dam sill removal activities would be scheduled to occur during late-summer months, when river flow conditions are generally the lowest of the year. Resulting construction rubble may be used for local stream bank stabilization as required, or disposed of within any of the CDFs used for sediment consolidation and disposal. After removal of the dam sills, some minor shaping of riverbeds and adjacent banks would be required to match surrounding contours. The new riverbanks would be seeded and mulched, and additional cover vegetation or trees added.

Implementation Issues

If the siting of a CDF within each former impoundment area proves to be unacceptably difficult, the conceptual plan presented here could be altered to use a mechanical dredging operation and off-site disposal. In this situation, a mechanical dredge and support equipment would be used to dredge the submerged sediments from the former impoundment areas. The access roads built to facilitate bank stabilization activities would be used to provide staging areas for the land-based aspects of this approach. Mechanically-dredged materials would be transferred from the river to shore by scows, where they would be stockpiled in temporary dewatering lagoons (similar in size and construction to CDFs).

Stockpiled dredged materials would be rehandled from the dewatering lagoons, blended with stabilizing agents (e.g., kiln dust, fly ash) as necessary, and mechanically dewatered with belt filter presses. The dewatered materials would be loaded into trucks and hauled to a local solid waste landfill for final disposal. If the PCB concentration of the material is above 50 milligrams per kilogram (mg/kg), it will need to be transported to a Toxic Substances Control Act (TSCA)-approved facility for disposal. Water removed from the lagoons and the belt filter presses would be treated at on-site treatment facilities and returned to the river.

The mechanical dredging-based approach would be slower and more expensive than the hydraulic dredging plan discussed here, due to the added steps of dredged material rehandling and dewatering, and the additional tipping fees that would be incurred at the landfill. While some savings would be possible due to a reduction in the amount of water entrained during the dredging process, it must be recognized that a significant quantity of water will still require treatment due to the need to render the dredged material sufficiently dry for acceptance at the landfill.

A CDF is a commonly-constructed technology for dewatering and containing dredged sediments. The introduction of PCB into a CDF adds an additional degree of complexity, and will likely require the use of synthetic liners, drainage layers, surface capping, and groundwater monitoring wells, which are not typically a part of CDF design. Since PCB typically adsorbs tightly to soil and sediment particles, it is not likely that PCB would migrate from the CDF; however, the CDF liners may be required to satisfy certain regulatory design requirements. Construction of the three CDFs will require significant amounts of local borrow material, sand, and final cap materials.

The water treatment unit processes of flocculation, sedimentation, multimedia filtration, and activated carbon adsorption are all established technologies, even for treatment rates in the range of 3 to 6 MGD. However, the variability of water generation rates and slurry composition, coupled with the anticipated low effluent discharge standards (especially problematic during the last few years of operation, when increased flow rates to the CDFs will coincide with the CDFs approaching design capacity, while having less buffering ability to attenuate large quantities of water) would likely cause problems that could potentially result in schedule delays. As a result, it may be necessary to slow down the dredging operations to accommodate water treatment processes as the CDFs begin to approach storage capacity.

Community and Agency Acceptance

Community receptivity presents an implementability concern for a project of this magnitude. The significant destruction of land and water habitats to support the CDFs and the dredging activities, remediation work traffic, noise associated with the project, and disruption of recreational use of the river will likely draw strong opposition from the local community. Since the Site is designated as a CERCLA site, permits are not required for on-Site activities. However, the substantive and applicable requirements of Federal and State regulations would need to be met, as discussed in the FS.

Long-Term Impacts

Impacts to habitat and biota will result from dredging of submerged sediments and from the change in water levels and flow that would result from dam sill removal. Dam sill removal is likely to cause significant loss of upstream wetland habitat due to decreased water levels, as well as loss of in-stream benthic and fish habitat as a result of increased stream channelization and flow. Dredging will affect approximately 9 river miles of in-river habitat and a minimum of 136 acres of wetland or terrestrial habitat (CDF area only – estimate does not include access roads or staging areas). Long-term aquatic impacts from dredging include the complete destruction of present benthic and fish habitat and homogenization of in-river substrate. Wetland and terrestrial impacts are associated with the construction of CDFs, access roads, and staging areas. Impacts associated with access roads and staging areas would be mitigated by implementing restoration measures; however, CDFs will remain in place post-remediation. Thus, some degree of recovery of aquatic and terrestrial habitat would be expected, but significant ecological impacts associated with dam removal and dredging within the former impoundments are still expected for existing habitat and biota.

In addition to the effects of dredging and dam removal, aquatic biota will be adversely affected by the destruction of stream bank and riparian vegetation associated with bank stabilization, exposed sediment cover, and general access road construction. This vegetation provides valuable stream cover that helps maintain and balance the productivity of the aquatic community. Although the aquatic community would be negatively impacted in the short-term from the removal of large woody debris associated with bank stabilization, the restoration efforts proposed as a part of the bank stabilization alternative would mitigate these impacts. In general, restoration measures will include revegetation of banks and access roads, and replacement of large woody debris. While these aquatic impacts would still be realized in the short term (e.g., 5 years), they would be significantly mitigated by the proposed restoration measures in the long term.

While some of the impacts to aquatic and terrestrial habitat and biota associated with this conceptual plan are expected to be short-term and/or mitigated by restoration measures, negative long-term impacts associated specifically with dredging and dam removal would be expected for aquatic, wetland, and terrestrial habitat and biota.

Cost

The total estimated cost of implementing the dredging, dewatering, bank stabilization, exposed soil covering and dam sill removal as described in this conceptual plan is $397,120,000. Further details regarding costs are presented in Tables 1 and 2.

Tables

TABLE 1

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

FEASIBILITY STUDY REPORT
PRELIMINARY COST ESTIMATE
DREDGING OF SUBMERGED SEDIMENTS, EXPOSED SEDIMENT SOIL COVER, BANK STABILIZATION AND REMOVAL OF DAM SILLS AT THE FORMER IMPOUNDMENTS WITH CONFINED DISPOSAL AT EXPOSED SEDIMENT LOCATIONS, INSTITUTIONAL CONTROLS, AND MONITORING

Item No.	Remedial Component	Quantity	Units	Unit Cost	Item Cost
A	**Pass 1 Construction**				
	Mobilization - 1	1	lump sum	$928,000	$928,000
	General Conditions	1	lump sum	$696,000	$696,000
	Project Insurance	1	lump sum	$464,000	$464,000
	Construction Trailers	24	month	$400	$10,000
	Clearing	105,000	linear foot	$21	$2,205,000
	Access road construction/restoration	247,000	square yard	$27	$6,669,000
	CDF A = 17.2 Acres	- -	- -	- -	- -
	CDF B = 43.7 Acres	- -	- -	- -	- -
	CDF C = 60 5 Acres	- -	- -	- -	- -
	CDF Land lease or purchase	136	acre	$8,000	$1,088,000
	CDF clearing & grubbing	136	acre	$7,700	$1,047,000
	CDF bedding	195,889	cubic yard	$20	$3,918,000
	CDF exterior dikes	710,044	cubic yard	$15	$10,651,000
	CDF interior dikes	597,914	cubic yard	$15	$8,969,000
	CDF liner, bot & walls	5,289,011	square foot	$0.50	$2,645,000
	CDF piping	51,565	linear foot	$12	$614,000
	CDF monitoring wells	17	well	$1,000	$17,000
	WTF site preparation & paving	72,600	square yard	$25	$1,815,000
	WTF coagulation/flocculation/sedimentation	3	lump sum	$656,000	$1,968,000
	WTF multimedia filters	3	lump sum	$474,000	$1,422,000
	WTF carbon adsorption	3	lump sum	$545,000	$1,635,000
	WTF control buildings	4,500	square foot	$70	$315,000
	WTF misc pumps, piping & electrical	1	lump sum	$1,431,000	$1,431,000
	SUBTOTAL				$48,507,000
	Engineering/Project Management (8%)				$3,881,000
	Construction Oversight (6%)				$2,910,000
	Contingency (20%)				$9,701,000
				TOTAL (YEARS 2005 - 2006):	$64,999,000
				PRESENT VALUE:	$46,343,000

(See notes on page 4)

TABLE 1

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

FEASIBILITY STUDY REPORT

PRELIMINARY COST ESTIMATE

DREDGING OF SUBMERGED SEDIMENTS, EXPOSED SEDIMENT SOIL COVER, BANK STABILIZATION AND REMOVAL OF DAM SILLS AT THE FORMER IMPOUNDMENTS WITH CONFINED DISPOSAL AT EXPOSED SEDIMENT LOCATIONS, INSTITUTIONAL CONTROLS, AND MONITORING

Item No.	Remedial Component	Quantity	Units	Unit Cost	Item Cost
B	**Pass 1 Field Operations**				
	Dredging mobilization - 1	1	lump sum	$2,013,000	$2,013,000
	General Conditions	1	lump sum	$1,509,000	$1,509,000
	Project Insurance	1	lump sum	$1,006,000	$1,006,000
	Construction Trailers	60	month	$400	$24,000
	Dredges, barges, pumps and boats	10 0	crew-year	$700,726	$7,007,000
	Dredge, boat and pump fuel use	10 0	crew-year	$654,410	$6,544,000
	Dredge labor	10.0	crew-year	$1,303,584	$13,036,000
	Dredge pipelines	10.0	crew-year	$696,960	$6,970,000
	Silt Curtains, reefing and anchoring	10.0	crew-year	$123,000	$1,230,000
	Turbidity monitoring stations	1	lump sum	$2,431,000	$2,431,000
	Shoreline protection	1	lump sum	$5,095,000	$5,095,000
	Operate CDF - labor	2,786	day	$3,086	$8,599,000
	CDF & WTF maintenance	5	year	$1,770,000	$8,850,000
	WTF chemicals	7,850	m gal	$1,500	$11,775,000
	WTF filter media	7,850	m gal	$200	$1,570,000
	WTF activated carbon	7,850	m gal	$1,860	$14,600,000
	Operate WTF - labor	2,786	day	$4,629	$12,899,000
	SUBTOTAL				$105,158,000
	Engineering/Project Management (5%)				$5,258,000
	Construction Oversight (6%)				$6,309,000
	Contingency (20%)				$21,032,000
				TOTAL (YEARS 2006 - 2010):	$137,757,000
				PRESENT VALUE:	$80,543,000
C	**Pass 2 Construction**				
	CDF and WTF mobilization - 2	1	lump sum	$563,000	$563,000
	General Conditions	1	lump sum	$423,000	$423,000
	Project Insurance	1	lump sum	$282,000	$282,000
	Construction Trailers	48	Month	$400	$19,000
	Bank stab. & habitat enhancement - Plainwell	1	lump sum	$3,800,000	$3,800,000
	Bank stab. & habitat enhancement - Otsego	1	lump sum	$5,000,000	$5,000,000
	Bank stab. & habitat enhancemt - Trowbridge	1	lump sum	$13,325,000	$13,325,000
	WTF coagulation/flocculation/sedimentation	3	lump sum	$656,000	$1,968,000
	WTF multimedia filters	3	lump sum	$474,000	$1,422,000
	WTF carbon adsorption	3	lump sum	$545,000	$1,635,000
	WTF misc pumps, piping & electrical	1	lump sum	$1,005,000	$1,005,000
	SUBTOTAL				$29,442,000
	Engineering/Project Management (8%)				$2,355,000
	Construction Oversight (6%)				$1,767,000
	Contingency (20%)				$5,888,000
				TOTAL (YEARS 2007 - 2010):	$39,452,000
				PRESENT VALUE:	$17,247,000

(See notes on page 4)

TABLE 1

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

FEASIBILITY STUDY REPORT

PRELIMINARY COST ESTIMATE

DREDGING OF SUBMERGED SEDIMENTS, EXPOSED SEDIMENT SOIL COVER, BANK STABILIZATION AND REMOVAL OF DAM SILLS AT THE FORMER IMPOUNDMENTS WITH CONFINED DISPOSAL AT EXPOSED SEDIMENT LOCATIONS, INSTITUTIONAL CONTROLS, AND MONITORING

Item No.	Remedial Component	Quantity	Units	Unit Cost	Item Cost
D	**Pass 2 Field Operations**				
	Dredging mobilization - 2	1	lump sum	$522,000	$522,000
	General Conditions	1	lump sum	$392,000	$392,000
	Project Insurance	1	lump sum	$261,000	$261,000
	Construction Trailers	48	month	$400	$19,000
	Dredges, barges, pumps and boats	1.4	year	$805,351	$1,127,000
	Dredge, boat and pump fuel use	1.4	year	$1,034,570	$1,448,000
	Dredge labor	1.4	year	$1,303,584	$1,825,000
	Dredge pipelines	1 4	year	$760,320	$1,064,000
	Silt Curtains, reefing and anchoring	1.4	year	$123,000	$172,000
	Turbidity monitoring stations	1	lump sum	$306,000	$306,000
	Shoreline protection	1	lump sum	$711,000	$711,000
	Operate CDF - labor	389	day	$3,086	$1,201,000
	CDF & WTF maintenance	4	year	$2,072,000	$8,288,000
	WTF chemicals	2,292	m gal	$1,500	$3,439,000
	WTF filter media	2,292	m gal	$200	$458,000
	WTF activated carbon	2,292	m gal	$1,860	$4,264,000
	Operate WTF - labor	389	day	$4,629	$1,801,000
	SUBTOTAL				$27,298,000
	Engineering/Project Management (5%)				$1,365,000
	Construction Oversight (6%)				$1,638,000
	Contingency (20%)				$5,460,000
				TOTAL (YEARS 2007 - 2010):	$35,761,000
				PRESENT VALUE:	$20,179,000
E	**Closure Construction**				
	Mobilization - 3	1	lump sum	$1,078,000	$1,078,000
	General Conditions	1	lump sum	$809,000	$809,000
	Project Insurance	1	lump sum	$539,000	$539,000
	Construction Trailers	108	month	$400	$43,000
	Exposed soil cover & veget. - Plainwell	1	lump sum	$2,426,727	$2,427,000
	Exposed soil cover & veget. - Otsego	1	lump sum	$3,170,364	$3,170,000
	Exposed soil cover & veget. - Trowbridge	1	lump sum	$15,393,142	$15,393,000
	3 Dam Removals	3	lump sum	$1,000,000	$3,000,000
	Decommission water treat facilities	1	lump sum	$5,846,000	$5,846,000
	CDF top liner	4,287,252	square foot	$0.50	$2,144,000
	CDF cover material	476,361	cubic yard	$25	$11,909,000
	CDF 2% graded cap	398,797	cubic yard	$25	$9,970,000
	SUBTOTAL				$56,328,000
	Engineering/Project Management (8%)				$4,506,000
	Construction Oversight (6%)				$3,380,000
	Contingency (20%)				$11,266,000
				TOTAL (YEARS 2012 - 2020):	$75,480,000
				PRESENT VALUE:	$25,960,000
	SUBTOTAL DREDGING CONSTRUCTION				$179,931,000
	SUBTOTAL DREDGING OPERATION				$173,518,000
	SUBTOTAL DREDGING				$353,449,000
	SUBTOTAL PRESENT WORTH DREDGING CONSTRUCTION				$89,550,000
	SUBTOTAL PRESENT WORTH DREDGING OPERATION				$100,722,000
	SUBTOTAL PRESENT WORTH DREDGING				$190,272,000

(See notes on page 4)

TABLE 1

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

FEASIBILITY STUDY REPORT

PRELIMINARY COST ESTIMATE

DREDGING OF SUBMERGED SEDIMENTS, EXPOSED SEDIMENT SOIL COVER, BANK STABILIZATION AND REMOVAL OF DAM SILLS AT THE FORMER IMPOUNDMENTS WITH CONFINED DISPOSAL AT EXPOSED SEDIMENT LOCATIONS, INSTITUTIONAL CONTROLS, AND MONITORING

Item No.	Remedial Component	Quantity	Units	Unit Cost	Item Cost
F	**Annual Costs**	Years	Annual	Total	Present Worth
	Bathymetric surveys	(2006 - 2011)	$50,000	$300,000	$170,000
	Confirmation sampling and analyses	(2006 - 2020)	$832,000	$12,480,000	$5,403,000
	Bank observation	(2010 - 2040)	$36,129	$1,120,000	$246,000
	Bank maintenance	(2010 - 2040)	$479,548	$14,866,000	$3,269,000
	Monitoring - biota	(2006 - 2041)	$142,306	$5,123,000	$1,323,000
	Monitoring - water & sed	(2006 - 2041)	$132,111	$4,756,000	$1,228,000
	KALSIM model updates	(2006 - 2041)	$123,000	$4,428,000	$1,143,000
	CDF & groundwater monitoring	(2007 - 2050)	$13,591	$598,000	$123,000
	SUBTOTAL ANNUAL				$1,809,000
	SUBTOTAL ANNUAL ALL YEARS				$43,671,000
	SUBTOTAL ANNUAL PRESENT WORTH ALL YEARS				$12,905,000
				GRAND TOTAL COST:	**$397,120,000**
				GRAND TOTAL PRESENT WORTH COST:	**$203,177,000**

NOTES/ASSUMPTIONS

General:

- All costs include material and labor, unless otherwise noted.
- Costs do not include legal fees, permitting, obtaining access, negotiations, or agency oversight.
- Unit costs are in 2000 dollars and are estimated from standard estimating guides (e.g., Means Site Work and Landscape Cost Data, vendors, professional judgement and experience from other similar projects).
- Costs based on current site information and project understanding. This may change following collection of additional data and/or receipt of Agency input and actual project design.
- Cost estimates are generally developed based on the USEPA guidance document "A Guide to Developing and Documenting Cost Estimates During the Feasibility Study", EPA 540-R-00-002 (OSWER 9355.0-75) dated July 2000.
- Present worth is estimated based on a 7 percent (%) beginning-of-year discount rate (adjusted for inflation) in accordance with USEPA policy directive entitled "Revisions to OMB Circular A-94 on Guidelines and Discount Rates for Benefit-Cost Analysis," OSWER Directive No. 9355.3-20 (USEPA, 1993). It is assumed that Year 0 is 2000.
- Engineering fees, project management and construction management are generally based on percentages shown on Exhibit 5-8 of the USEPA guidance document for feasibility study (OSWER 9355.0-075).
- A 20% contingency allowance is included to provide for unforeseen circumstances or variability in estimated areas, volumes, labor and material costs.

Specific:

- Mobilization/demobilization is a lump sum based on project size.
- General conditions refer to contractor overhead, and miscellaneous costs such as health and safety and construction trailer facility. Cost is a lump sum based on project size.
- Labor prices in accordance with Prevailing Rate Schedule, Kalamazoo Co., 1/1/2000 at 40hrs/wk/shift straight time and 14hrs overtime/wk/shift.
- Access area development includes clearing and preparation of equipment and material staging/handling areas Restoration includes the removal and disposal of gravel, fill replacement, where necessary, followed by topsoil and vegetation.
- Access road construction assumes construction and restoration of a 16-foot wide roadway along both sides of the former impoundments, along one side of the in-between stretches and as needed to access the current impoundments, as further described in Alternatives 3 and 4 .
- Bank Stabilization costs as described for Alternatives 3 and 4, including components for Plainwell, Otsego, and Trowbridge Impoundments.
- Dredging by hydraulic cutterhead dredge, assuming 600 cy/day production when dredging in the Kalamazoo River and 2000 cy/day production when dredging in Lake Allegan. A second overdredge of a 6-inch layer is assumed for all areas.
- Cost of 13" Cutterhead Dredge at $2,400,000 amortized at 7.0% for 15-year life results in annual owner cost of $263,507.

TABLE 1

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

FEASIBILITY STUDY REPORT
PRELIMINARY COST ESTIMATE
DREDGING OF SUBMERGED SEDIMENTS, EXPOSED SEDIMENT SOIL COVER, BANK STABILIZATION AND REMOVAL OF DAM SILLS AT THE FORMER IMPOUNDMENTS WITH CONFINED DISPOSAL AT EXPOSED SEDIMENT LOCATIONS, INSTITUTIONAL CONTROLS, AND MONITORING

- Dual layer vinyl coated polyester silt curtain includes reefing and anchoring. It is assumed that 3800 linear feet will be replaced yearly. Silt curtain based on Elastec quotation, 9/98 escalated to 1/00.
- Five real-time turbidity monitoring stations are used for each dredging segment. Fixed monitoring stations are constructed of 6-in steel piling for each dredging segment, and removed after dredging. It is assumed that turbidity sensors will be replaced every 90,000 cy of dredging.
- Sheet piling will be placed along certain stretches to protect onshore facilities from dredging disturbance. It is assumed that this will be required along 10 percent of the shoreline.
- Cost of Boat at $350,000 amortized at 7.0% for 10-year life results in annual owner cost of $49,832.
- Boat consumes total energy of 35 HP at Engine Fuel Factor (EFF) of 0.042 and fuel price of $1.80/ gal, for fuel costs of $2.65 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $0.265 per hr or $3.71 per day, for total fuel costs of $30 per day.
- 6 miles avg. pipeline reach
- First-pass dredging of Kalamazoo River segments at: 60 cy/hr; 10 hrs/day; 6 days/wk; 4 wk/mo; 10 mo/yr; 2400 hrs/yr; or 144,000 cy/yr
- In-situ solids = 77%; dredge solids = 5%; dredge slurry pumping rate = 12.9 cfs during 10-hr/day.
- Cost of 13" Cutterhead Dredge at $2,400,000 amortized at 7.0% for 15-year life results in annual owner cost of $263,507.
- 13" Cutterhead Dredge consumes total energy of 2630 HP at EFF of 0.042 and fuel price of $1.80/ gal, for fuel costs of $199 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $19.9 per hr or $279 per day, for total fuel costs of $2269 per day.
- Three 13-inch booster pumps consume total energy of 311 HP at EFF of 0.042 and fuel price of $1.80/ gal, for fuel costs of $24 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $2.4 per hr or $34 per day, for total fuel costs of $274 per day.
- Second-pass dredging of Kalamazoo River segments at: 60 cy/hr; 10 hrs/day; 6 days/wk; 4 wk/mo; 10 mo/yr; 2400 hrs/yr; or 144,000 cy/yr
- In-situ solids = 77%, dredge solids = 2.5%; dredge slurry pumping rate = 26.2 cfs during 10-hr/day.
- Cost of 18" Cutterhead Dredge at $3,900,000 amortized at 7.0% for 20-year life results in annual owner cost of $368,132.
- 18" Cutterhead Dredge consumes total energy of 4148 HP at EFF of 0.042 and fuel price of $1.80/ gal, for fuel costs of $314 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $31.4 per hr or $440 per day, for total fuel costs of $3580 per day.
- Three 18-inch booster pumps consume total energy of 630 HP at EFF of 0.042 and fuel price of $1.80/ gal, for fuel costs of $48 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $4.80 per hr or $67 per day, for total fuel costs of $547 per day.
- CDF area requirement is based on achieving long-term solids content of 47% w/w in facilities with 20-ft ultimate height. Three facilities are anticipated, with total containment volume of 2.5 million cy. Side slopes of 1:3 add additional area requirements, in addition to adjacent facilities for water treatment.
- CDF sizing is in accordance with Engineer Manual 1110-2-5027, Engineering and Design, Confined Disposal of Dredged Material, USACE (30 Sep 1987).
- CDFs are assumed to contain a sand bedding of 1-ft, underdrains and polyethylene lining, prior to commencement of operation. Sizing of the CDFs assume 8 internal dikes will be constructed to facilitate operation and consolidation of sediment.
- Water treatment for overflow of dredge water from the CDF consists of flocculation, sedimentation, dual-media filtration and activated carbon adsorption. Discharge is to the Kalamazoo River or Lake Allegan. Treatment facilities are located adjacent to each of the three CDFs. Unit costs are based on experience at the Fox River SMU 56/57, with elimination of neutralization chemical costs. Flocculation and sedimentation assume 60 min. detention, filtration facilities are assumed to be loaded at 2.0 gpd/sf, and carbon contactors assume empty bed contact time of 20 min.
- Control building of 1500 square ft to be constructed for each WTF.
- Closure of completed CDFs, after five years of final consolidation, would consist of a polyethylene membrane, one foot of soil cover and a 2%-sloped soil cap for runoff control.
- Bathymetric surveys are performed annually during dredging to confirm effectiveness.
- Confirmation Sampling includes analyses and QA/QC for in-situ sediments, waters and residuals for dredging and water treatment operations.
- Construction oversight includes project management and daily reports.
- Engineering fees are based on 8% of the construction subtotal cost or 5% of operational costs during field execution.
- Contingency is based upon 20% of the construction subtotal cost.
- Present worth dredging and disposal cost assumes costs are spread evenly over the duration of each program segment, at a 7% discount rate.
- Present worth cost includes institutional controls and monitoring. Samples for Advisory Monitoring of Biota are taken at year 1, then every 5 years until 30 years after completion of dredging. Samples for Trend Monitoring of Biota are taken at year 1, then every 3 years until 30 years after completion of dredging. Water and sediment samples are taken at year 1, then every 5 years until 30 years after completion of dredging. KALSIM model updates are performed at year 1, then every 5 years until 30 years after completion of dredging.
- Annual costs for maintenance of restored impoundments as developed for Alternative 3.
- CDF monitoring consists of sampling and analyses of perimeter monitoring wells for 52 years.
- Total present worth cost is the sum of costs for dredging, disposal, water treatment, institutional controls, and monitoring.

TABLE 2

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

FEASIBILITY STUDY REPORT
DREDGE COST ASSUMPTIONS
DREDGING OF SUBMERGED SEDIMENTS, EXPOSED SEDIMENT SOIL COVER, BANK STABILIZATION AND REMOVAL OF DAM SILLS AT THE FORMER IMPOUNDMENTS WITH CONFINED DISPOSAL AT EXPOSED SEDIMENT LOCATIONS, INSTITUTIONAL CONTROLS, AND MONITORING

SEGMENTS A1 & B1 & C1

- First-pass dredging of Kalamazoo River segments at: 60 cy/hr; 10 hrs/day; 6 days/wk; 4 wk/mo; 10 mo/yr; 2400 hrs/yr; or 144,000 cy/yr
- In-situ solids = 77%; dredge solids = 5%; dredge slurry pumping rate = 12.9 cfs during 10-hr/day.
- Dredge sizing to maintain pipeline velocity of 15 fps is 12.6 inches; therefore select 13-inch dredge.

Equipment and Operating Costs

	Item	No.	Units	Unit cost	(Annual) Tot cost
1	13" Cutterhead Dredge	240	days	$1,098	$263,507
2	Boat	240	days	$208	$49,832
2	Boat	240	days	$208	$49,832
3,4	Fuel	240	days	$2,331	$559,320
5	Dredge operator (3 shifts/day)	40	weeks	$5,905	$236,201
6	Engineer (3 shifts/day)	40	weeks	$5,779	$231,142
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
2	Barge for debris	240	days	$59	$14,238
2	Barge for debris	240	days	$59	$14,238
2	Boat, debris crew	240	days	$208	$49,832
4	Fuel	240	days	$31	$7,440
2	Boat, debris crew	240	days	$208	$49,832
4	Fuel	240	days	$31	$7,440
7	Laborer (1 shift/day), debris	40	weeks	$1,549	$61,976
7	Laborer (1 shift/day), debris	40	weeks	$1,549	$61,976
7	Laborer (1 shift/day), debris	40	weeks	$1,549	$61,976
8	Silt Curtains, reefing and anchoring	3,800	LF/yr	$32	$123,000
2	Boat	240	days	$208	$49,832
4	Fuel	240	days	$30	$7,200
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
9	3 Booster pumps and barges	240	days	$457	$109,751
10	Booster pump fuel	240	days	$274	$65,760
11	13" Pipeline	31,680	LF/yr	$22	$696,960
2	Boat	240	days	$208	$49,832
4	Fuel	240	days	$30	$7,250
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
				Total:	$3,478,681
				Total $/cy dredged:	$24.16

Notes

1. Cost of 13" Cutterhead Dredge at $2400000 amortized at 7.0% for 15-year life results in annual owner cost of $263,507.
2. Cost of Boat at $350,000 amortized at 7.0% for 10-year life results in annual owner cost of $49,832.
3. 13" Cutterhead Dredge consumes total energy of 2630 HP at Engine Fuel Factor (EFF) of 0.042 and fuel price of $1.8/ gal, for fuel costs of $199 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $19.9 per hr or $279 per day, for total fuel costs of $2269 per day
4. Boat consumes total energy of 35 HP at Engine Fuel Factor (EFF) of 0.042 and fuel price of $1.8/ gal, for fuel costs of $2.65 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $0.265 per hr or $3.71 per day, for total fuel costs of $30 per day.
5. Crane engineer, Prevailing Rate Schedule, Kalamazoo Co., 1/1/2000 at 33.35$/hr, straight for 40hrs/wk/shift and 45.31$/hr, ot for 14hrs ot/wk/shift, resulting in 1,968.34$/wk/shift or 5,905.02$/wk for 3 shifts
6. Class I engineer, Prevailing Rate Schedule, Kalamazoo Co., 1/1/2000 at 32.66$/hr, straight for 40hrs/wk/shift and 44.27$/hr, ot for 14hrs ot/wk/shift, resulting in 1,926.18$/wk/shift or 5,778.54$/wk for 3 shifts.
7. Laborer Class B, Prevailing Rate Schedule, Kalamazoo Co., 1/1/2000 at 22.52$/hr, straight for 40hrs/wk/shift and 32.43$/hr, ot for 14hrs ot/wk/shift, resulting in 1,354.82$/wk/shift or 4,064.46$/wk for 3 shifts. Debris crew at 10 hrs/day or 40 hrs straight time and 20 hrs ot per week
8. Elastec quotation, 9/98 escalated to 1/00, replace yearly.
9. Cost of 3 Booster pumps and barges at $450,000 amortized at 7.0% for 5-year life results in annual owner cost of $109,751
10. Three 13-inch booster pumps consume total energy of 311 HP at EFF of 0.042 and fuel price of $1.8/ gal, for fuel costs of $24 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $2.4 per hr or $34 per day, for total fuel costs of $274 per day.

TABLE 2

ALLIED PAPER, INC./PORTAGE CREEK/KALAMAZOO RIVER SUPERFUND SITE

FEASIBILITY STUDY REPORT
DREDGE COST ASSUMPTIONS
DREDGING OF SUBMERGED SEDIMENTS, EXPOSED SEDIMENT SOIL COVER, BANK STABILIZATION AND REMOVAL OF DAM SILLS AT THE FORMER IMPOUNDMENTS WITH CONFINED DISPOSAL AT EXPOSED SEDIMENT LOCATIONS, INSTITUTIONAL CONTROLS, AND MONITORING

11 6 miles avg. pipeline reach

SEGMENTS A2 & B2 & C2

- Second-pass dredging of Kalamazoo River segments at: 60 cy/hr; 10 hrs/day; 6 days/wk; 4 wk/mo; 10 mo/yr; 2400 hrs/yr; or 144000 cy/yr
- In-situ solids = 77%; dredge solids = 2.5%; dredge slurry pumping rate = 26.2 cfs during 10-hr/day.
- Dredge sizing to maintain pipeline velocity of 15 fps is 17.9 inches; therefore select 18-inch dredge.

Equipment and Operating costs

	Item	No.	Units	Unit cost	(Annual) Tot cost
1	18" Cutterhead Dredge	240	days	$1,534	$368,132
2	Boat	240	days	$208	$49,832
2	Boat	240	days	$208	$49,832
3,4	Fuel	240	days	$3,642	$873,960
5	Dredge operator (3 shifts/day)	40	weeks	$5,905	$236,201
6	Engineer (3 shifts/day)	40	weeks	$5,779	$231,142
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
2	Barge for debris	240	days	$59	$14,238
2	Barge for debris	240	days	$59	$14,238
2	Boat, debris crew	240	days	$208	$49,832
4	Fuel	240	days	$31	$7,440
2	Boat, debris crew	240	days	$208	$49,832
4	Fuel	240	days	$31	$7,440
7	Laborer (1 shift/day), debris	40	weeks	$1,549	$61,976
7	Laborer (1 shift/day), debris	40	weeks	$1,549	$61,976
7	Laborer (1 shift/day), debris	40	weeks	$1,549	$61,976
8	Silt Curtains, reefing and anchoring	3,800	LF/yr	$32	$123,000
2	Boat	240	days	$208	$49,832
4	Fuel	240	days	$30	$7,200
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
9	3 Booster pumps and barges	240	days	$457	$109,751
10	Booster pump fuel	240	days	$547	$131,280
11	18" Pipeline	31,680	LF/yr	$24	$760,320
2	Boat	240	days	$208	$49,832
4	Fuel	240	days	$30	$7,250
7	Laborer (3 shifts/day)	40	weeks	$4,064	$162,578
				Total:	$4,026,826
				Total $/cy dredged:	$27.96

Notes

1 Cost of 18" Cutterhead Dredge at $3,900,000 amortized at 7.0% for 20-year life results in annual owner cost of $368,132.

2 Cost of Boat at $350,000 amortized at 7.0% for 10-year life results in annual owner cost of $49,832.

3 18" Cutterhead Dredge consumes total energy of 4148 HP at EFF of 0.042 and fuel price of $1.8/ gal, for fuel costs of $314 per hour for 10 active hours per day, while idling 14 hrs per day, fuel costs are $31.4 per hr or $440 per day, for total fuel costs of $3,580 per day.

9 Cost of 3 Booster pumps and barges at $450,000 amortized at 7.0% for 5-year life results in annual owner cost of $109,751.

10 Three 18-inch booster pumps consume total energy of 630 HP at EFF of 0.042 and fuel price of $1.8/ gal, for fuel costs of $48 per hour for 10 active hours per day; while idling 14 hrs per day, fuel costs are $4.8 per hr or $67 per day, for total fuel costs of $547 per day.

11 6 miles avg. pipeline reach

4

c

REMOVAL OF SMALL DAMS

MILONE & MACBROOM, INC.
Cheshire, Connecticut

BREACH CONTROL FACTORS

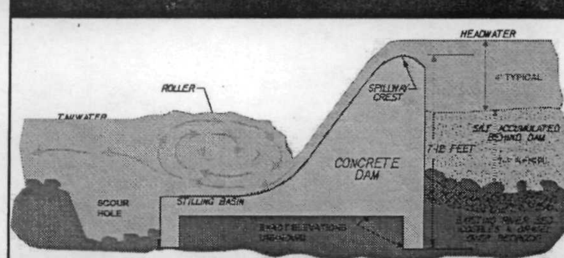
- Location
- Size & depth
- Incremental time steps
- Prior drawdown

DAM REMOVAL ISSUES

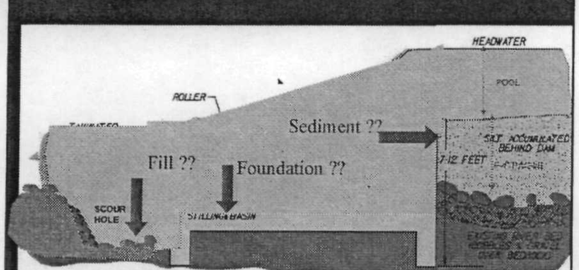
- 0N-SITE SAFETY
- DAM FAILURE SAFETY
- WATER & ECONOMIC USE
- SEDIMENT MANAGEMENT
- COMMUNITY/RECREATION ENVIRONMENTAL IMPACTS
- DESIGN/CONSTRUCTION

DAM CROSS SECTION

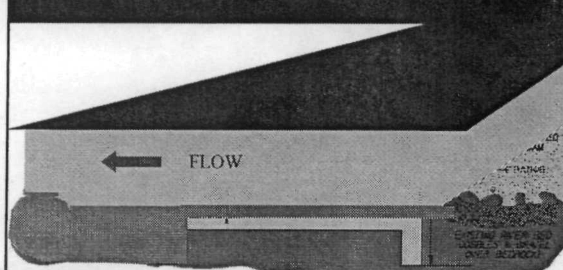
NTS

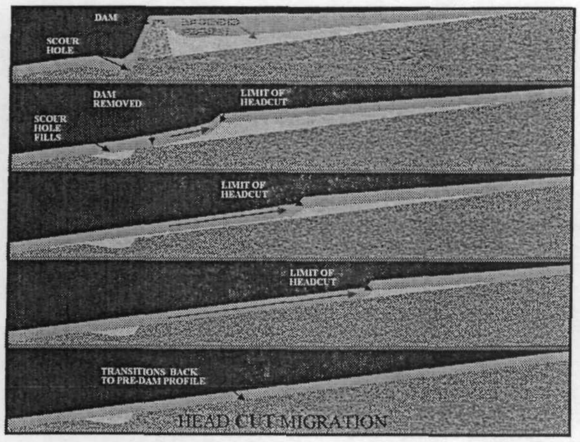


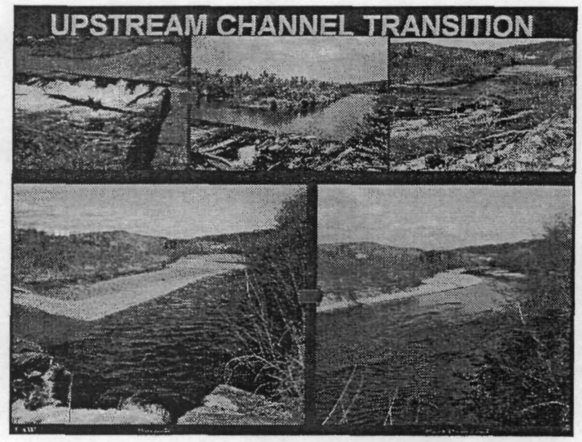
CHANNEL MODIFICATIONS AT DAM



FINAL MODIFICATIONS AT DAM







ENVIRONMENTAL ISSUES

- WATER QUALITY
- PUBLIC HEALTH
- AQUATIC HABITAT
- ANADROMOUS & RESIDENT FISHERIES (Integration of Species Separated by Dam)
- VEGETATION
- WILDLIFE
- SPECIES OF SPECIAL CONCERN

HYDRAULIC ISSUES

- WATERSHED HYDROLOGY
- CHANNEL HYDRAULICS
- *FLOODWATER STORAGE*
- CHANNEL MORPHOLOGY (Stability, Channel Size, Width/Depth Ratio, Slope, Floodplain Function)
- IMPOUNDMENT DRAWDOWN (Exposed Lake/Riverbed, *Wetland Abandonment & Creation*, Impacts on Aquifers)
- WATER TEMPERATURE

SEDIMENT ISSUES

- SEDIMENT QUALITY & QUANTITY
- SEDIMENT STABILITY
- SEDIMENT TRANSPORT
- STABILIZE, REMOVE OR NATURAL EROSION
- DREDGE DISPOSAL
- DOWNSTREAM SEDIMENT TRAP

PASSAGE ALTERNATIVES

- MODIFY OR LOWER DAM
- REMOVE DAM
- *TRAP AND HAUL*
- ROUGHENED RAMP
- BY-PASS CHANNEL
- FISH ELEVATOR/LIFT
- FISH LADDER
- COMBINATION OF METHODS

DESIGN/CONSTRUCTION ISSUES

- PROJECT PERMITTING (State, Federal, Local, Possible EIS)
- DESIGN PLANS & SPECIFICATIONS
- PROJECT COST
- EASEMENTS
- CONSTRUCTION ACCESS
- WATER CONTROL
- SEASONAL CONSTRUCTION LIMITS
- CONSTRUCTION SEQUENCE
- SITE RESTORATION

DAM REMOVAL FALLACIES

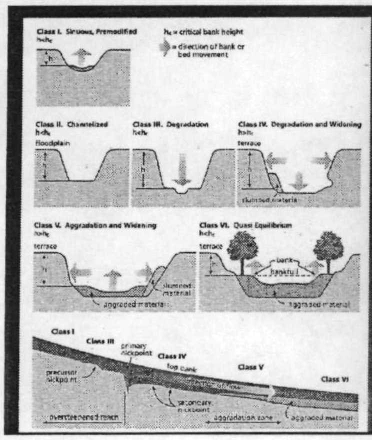
- All dams have sediments
- All Impounded sediments will erode
- Barren mud flats last forever
- River dries up
- Upstream channels headcut
- All the fish die

CHANNEL EVOLUTION ISSUES

- Forecast potential natural response
  - ✓ Empirical approach
  - ✓ Comparative analogies
  - ✓ Analytical approach
- Accept or reject natural response
- Modify natural response

GEOMORPHIC ISSUES

- Sediment load & gradation
- Sediment deposit type
- Reservoir / river widths ratio
- Retention time



INCISED CHANNEL EVOLUTION MODEL

SCHUMM, HARVEY, WATSON 1984

RIVER PROFILE SLOPES *

Classification	Typical Substrate	Slope Range %
Cascades	Boulders	5 – 30
Step Pools	Cobble, Boulders	3 – 8
Rapids	Gravel, Cobbles	1 – 4
Pool Riffles	Gravel	0.1 – 2
Dune Bed	Sand	< 0.1

* Modified from Montgomery & Buffington, 1993

INCISED CHANNELS

- Degrade below surroundings
- Steep banks
- Bed erodes faster than banks
- Disconnected from floodplain
- Concentrates flood flows
- Under cuts tributaries
- Sediment source

SEDIMENT SCOUR PROCESSES

- Surface sheet erosion & rills
- Main channel erosion
- Tributary incision
- Impoundment perimeter landslides
- Channel meanders
- Seepage & piping

CHANNEL DEGRADATION PROCESS

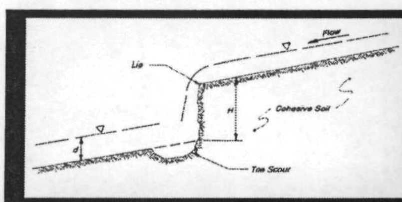
- Progressive bed erosion
- Retrogressive head cuts

PROGRESSIVE DEGRADATION

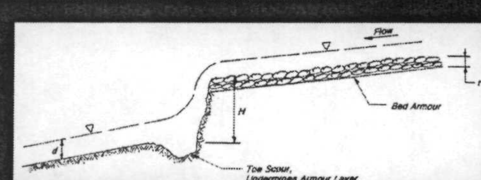
- Shear stress > critical threshold
- Sediment transport > sediment supply
- Extends upstream to downstream
- Upstream sediments may redeposit downstream

RETROGRESSIVE DEGRADATION

- Common in cohesive soils
- Plunging flow causes scour
- Extends from downstream to upstream



Cohesive Soil Headcut
d < H



Armored Bed Headcut
d < H & H > t

KNICKPOINTS & HEADCUTS

COMMON

- Cohesive Soils
- Armored Beds
- Compact Soils
- Downstream Initation

LESS COMMON

- Granular Soils
- Poorly Graded
- Loose Soils
- Threshold Velocity

ADVERSE IMPACTS DUE TO CHANNEL INCISION

NATURAL

CREATES EXCESS SEDIMENT
BANKS ERODE, TREES COLLAPSE
LOWERS ALLUVIAL GROUNDWATER LEVELS
CREATES UNSTABLE BED HABITAT
REDUCES BIOLOGICAL DIVERSITY
HIGHER VELOCITIES OCCUR
REDUCES FLOODWATER STORAGE
INCREASED PEAK FLOOD FLOWS
KNICKPOINTS INHIBIT FISH PASSAGE
SEDIMENTS FILL DOWNSTREAM LAKES

ANTHROPOGENIC

UNDERMINES BRIDGES
EXPOSES UTILITY PIPES
RESERVOIR SEDIMENTATION
LOSS OF RIVERBANK LAND
DOWNSTREAM FLOOD DAMAGES
POOR CHANNEL ACCESS
DEGRADES WATER QUALITY

RIVER RESTORATION ANALYSIS, POST DAM REMOVAL

Presented by:

James MacBroom , PE
Milone & MacBroom Inc
Cheshire, CT

RIVER RESTORATION

- WATERSHED MANAGEMENT
- "NATURAL" CHANNEL DESIGN
- INSTREAM HABITAT
- FISH PASSAGE / DAM REMOVAL
- STREAM FLOWS
- SEDIMENT TRANSPORT
- RIPARIAN HABITAT / VEGETATION
- ACCESS / RECREATION
- DAYLIGHTING

RE-CREATED CHANNEL GOALS

- HYDRAULIC CONVEYANCE
- SEDIMENT TRANSPORT CONTINUITY
- ECOLOGICAL CONNECTIVITY
- RECREATIONAL OPPURTUNITIES
- AESTHETICS
- REGULATORY COMPLIANCE
- ECONOMICS

APPLIED FLUVIAL MORPHOLOGY

- REGIME METHOD
- HYDRAULIC GEOMETRY EQUILIBRIUM
  - LEOPOLD, MADDOCK, WOLMAN DATA
  - REGIONAL DATA
  - SCHUMM SILT / CLAY FACTOR
  - ROSGEN CLASSIFICATIONS
- INCIPIENT MOTION
  - THRESHOLD VELOCITY
  - TRACTIVE SHEAR STRESS
- SEDIMENT TRANSPORT CONTINUITY
- MOBILE BOUNDARY SEDIMENT ROUTING

MODIFY NATURAL RESPONSE

SEDIMENT	CHANNEL
• REMOVE SEDIMENT	• CREATE REGIME CHANNEL
• RELOCATE SEDIMENT	• ARMORED CHANNEL
• CONTAIN SEDIMENT	• GRADE CONTROLS
• COMBINATION	• COMBINATION

HYDRAULIC EQUATIONS

CONSERVATION OF MASS & CONTINUITY

$Q_1 = Q_2 + \Delta Q$

$Q = VA = V\,Y\,b$

CONSERVATION OF MOMENTUM

$M_1V_1 = M_2V_2$

CONSERVATION OF ENERGY

$E = Y + \frac{V^2}{26}$ (Specific Energy)

$E1 = E2 + \Delta E$ (Total Energy)

MANNINGS EQUATION

$V = \frac{1.486}{N} R^{2/3} S^{1/2}$

THRESHOLD VELOCITY

- Fortier & Scoby Table
- Shields Diagram (ASCE)
- Bureau of Public Roads
- $V_s = 2.6356\, D_{75}^{\,0.30596}$ Sands (SCS)
  $V_s = 1.4653\, D_{75}^{\,0.38}$ Gravel (SCS)
- $V_s = 143\, d^{1/3} D_{75}^{\,2/3}$ (Neill, Corps)
- $V_s = 11.52\, Y^{1/6} D_{50}^{\,1/3}$ (Neill, HEC-18)
- $V_s = 0.5\, D^{0.5}$ (Mavis & Laushey)

TRACTIVE SHEAR STRESS

A. **Critical Shear Stress**

$\tau_c = 5\, D_{50}$ (SCS)
$\tau_c = 4.1\, D_{50}$ (Corps.)
$\tau_c = 6.18\, D_{50}$ (Shields)

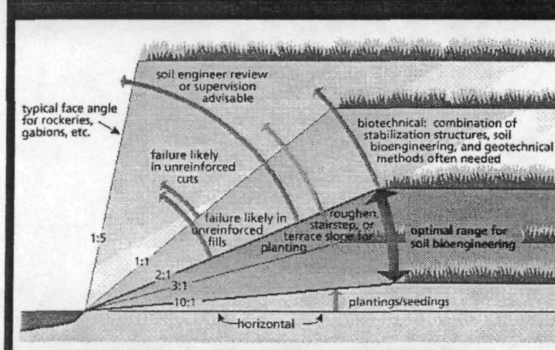
B. **Tractive Stress**

$\tau = \gamma RS$ (Uniform Flow)
$\tau_o = (\gamma V^2)/(32.62 \log(Y/D_{50}))^2$ (Corps)

BANK EROSION INITIATION

- High velocity
- Degradation
- Bends
- Constrictions
- Convergence
- Obstructions
- Sediment deficits

WHEN TO USE HARD OR SOFT BANK PROTECTION



MODIFY NATURAL RESPONSE

SEDIMENT MANAGEMENT
- Remove Sediment
- Relocate Sediment
- Contain Sediment
- Combination

CHANNEL MANAGEMENT
- Create Regime Channel
- Create Armored Channel
- Install Grade Controls
- Combination

CHANNEL STABLIZATION METHODS

CROSS SECTION ELEMENT	LOW 0-3 FPS	VELOCITY ZONES MEDIUM 3-7 FPS	HIGH >7 FPS
STREAMBED	NATURAL	GRAVEL LAYER BOULDER CLUSTERS COBBLE BARS ROCK SILLS WING DEFLECTIONS	CHECK DAMS LOG SILLS COBBLE LAYER FULL RIPRAP GEO-GRIDS

SEDIMENT TESTING
QUALITY & QUANTITY

- FIELD INVESTIGATION
- SEDIMENT SAMPLING PLAN (with regulatory review)
- HAND BORINGS/PROBES
- MECHANICAL BORINGS
- PHYSICAL PARAMETERS
  - grain size
  - organic content
  - moisture content (if dredging)
- CHEMICAL PARAMETERS
  - will vary by state
  - look at upstream uses
  - state disposal criteria
  - elutriate testing

SEDIMENT TRANSPORT/STABILITY COMPUTER MODELS

Individual Cross-Section ,1-D, Steady State

- SEDIMENT (Corps.)
- SEDISCH (Stevens & Yang)
- SAM (Corps.)
- HEC-RAS w/ Stability Analysis

ADVANCED SEDIMENT TRANSPORT STABILITY COMPUTER MODELS

Non-Uniform Flow

FIXED WIDTH
- HEC-6 (Corps.)

VARIABLE WIDTH
- GSTARS (Molinas & Yang)
- FLUVIAL (Chang)

2- & 3-DIMENSIONAL
- SED2D (Corps)
- MIKE (Delft Hydraulics)

CHANNEL OPTIONS

- DO NOTHING
- VERTICAL GRADE CONTROLS
- HORIZONTAL BOUNDARY CONTROLS
- CREATE REGIME CHANNEL
- CREATE ARMORED CHANNEL
- BYPASS IMPOUNDMENT

Sediment Disposal

CLEAN FILL (or similar to background levels)

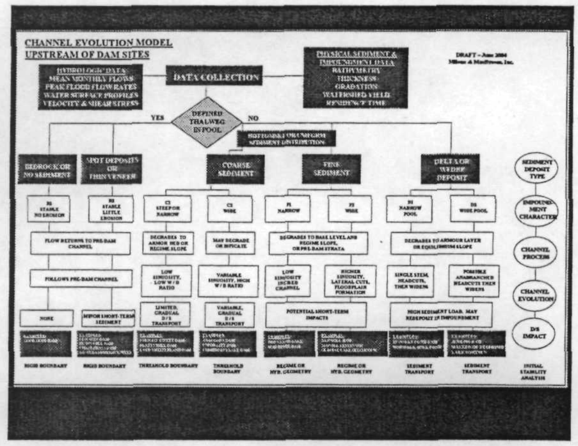
- Natural River Erosion
- Downstream Sediment Trap
- Reuse On-site
- Clean Fill or Topsoil (if highly organic)
- Ocean Disposal

LOW LEVELS OF CONTAMINANTS

- Limited use Fill/Disposal (i.e. industrial fill, concrete mix , road base)
- Landfill Capping/Fill Material
- Unlined Landfill

CONTAMINATED

- Lined Landfill
- Hazardous Waste Disposal Site
- Treatment then Disposal



BEYOND THE DAM:
WHEN DOES DAM REMOVAL MAKE SENSE?

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I. Introduction

For the last 4,000 years man has been attempting to control the rivers of the world. The physical control of rivers was deemed as necessary and important if man was to dictate the manifest destiny of growth and development. The landscape that we inhabit on this Earth was formed by the combined actions of land and water shaping and massaging the geology of the land. Fragmenting rivers and watersheds disrupts the natural processes necessary to sustain ecological systems and the evolution of the landscape.

Our relationship to water and rivers has changed over the last 4,000 years. It is widely believed that early civilization evolved in the area today known as the *Fertile Crescent*, that area of land between the Tigris and Euphrates Rivers in the Middle East. Early man viewed and worshipped rivers as the rejuvenator of the lands and supplier of food and nutrients necessary for survival. People celebrated the annual spring floods that rejuvenated the landscape and soils and provided the bounty of fish and plants so important to survival. It is no coincidence that the evolution of man began and was centered on rivers, as water is critical to survival. Early man had a reverence for the rivers and lakes and realized that they provided the wealth of the land. Water was not a commodity; it was an integral and communal part of life itself.

As man began to spread out into other areas he developed a new relationship with water. Rivers and lakes were not seen as community property but were instead viewed as entities for development and control. First rivers were used as conduits for transportation and commerce. River travel was necessary to move goods and people up and down the watersheds. River were used as conduits of waste and people. Dominance over the water required man to control it in order to profit from it. Dams began to be seen as necessary for control of the rivers and along the way the perception of water changed from one of being an *integral component* of our life to a view of water being a *utilitarian commodity* to be controlled, marketed and generally taken for granted. This change in our relationship to water and rivers set the stage for the era of dams to emerge.

Dams have been marketed as the panacea for the management of water and controlling rivers. The result has been the unnatural manipulation of rivers and has resulted in the loss of the ecological and social integrity of the fish, wildlife, vegetation and peoples who have evolved with the natural flowing rivers. Dams have left us with a false sense of security for flood control, water management and navigation. Long-term integrity of river systems requires that we look beyond the concrete and take into consideration watershed and river dynamics.

II. The Religion of Dams

Beginning in the early -1800's, dams began to become a much more important part of the landscape of river systems. Early dams were small, usually constructed on smaller tributaries and upstream of areas that experienced significant seasonal flooding. The control of rivers with dams began simply enough - first for powering mill wheels for grinding grains and cutting lumber for housing and building. As experience and need expanded, dams did to, both in size and number. Dams have been built to meet the need in five major areas:

- Flood control
- Irrigation
- Hydroelectricity
- Development
- Recreation

Today over 75,000 dams exist in the United States alone with an approximate 2.5 million existing throughout the world. Of this total over 45,000 large dams have been built in the last century alone. As the size of the dams increases so does the amount of water that is stored behind them. To put that number into perspective, that represents approximately *one-dam a day being constructed in the United States from July 4, 1776 to the present.* Dams have become integral parts of our landscape and have reshaped rivers and their watersheds.

Dams come in a variety of sizes from small (less than 100 acre feet) to large (greater than 1 million acre-feet). The majority of dams are small to medium size with control and management defined by local, regional and national regulations. While sizes of dams differ the impacts of small dams may be as significant as the larger ones.

Dams have become a religion onto themselves as man has enforced his domination over the rivers and waters of this Earth.

Dams and the development of rivers have become a national and an international symbol of success. The World Bank and other funding entities have regularly financed billions of dollars to construct dams as centerpieces of development in third world and developing countries. The investment has been high and so has the costs associated with this religion of dams (World Commission on Dams, 2000).

III. An Evolving Perspective on the Importance of Rivers

Beginning in the early 1980's dams and rivers began to be looked at differently. Attributing this change in perspective and attitude to one specific event or example is not possible. This change in perspective has come about as our cumulative knowledge about the effects of dams has increased and we have learned that dams have not met the short-term expectations that many had predicted. Our reassessment of dams has begun at local levels associated with small dams that have grown old, has expanded to regional and watershed levels on a national basis and is now being debated internationally as investors question the potential return on their investment dollars.

Recently the World Commission on Dams completed a comprehensive and global assessment of the benefits and disadvantages of large dams (dams greater than 15 meters tall and impounding over 3 million cubic meters of water) and concluded that *dams have made an important and significant contribution to human development ... but in too many cases, the social and environmental costs have been unacceptable and often unnecessary* (WCD, 2000). In the

United States the issue of dams and their longevity came full circle when the Edwards Dam on the Kennebec River in Maine was officially decommissioned and removed in July 1999. Clearly the era of big dams is over. The vision of the future includes not the subjugation of rivers with dams but a restoration of river processes and function. In essence, finding alternatives to dams.

- **Dam Decommissioning is not a New Concept**

Local, usually private interests, whose intent was to control rivers for economic development, initially developed dams. As dams grew in size and as the potential impacts of their placement increased local governments and private investors began to take more of an active role in building dams. In the early 1900's as the size of dams grew, the Federal government became more of the dominant players and financiers in dam development. Around the world international financiers and governments decided that dams were symbols of power and standing. Unfortunately the concept of watershed integrity was sidestepped in the desire to build monuments to governments and power. As much as we have learned about ecosystem management and the problems of large dams, incomplete decision-making continues.

In the United States there are three primary groups who control the dam building efforts:

- Federal - Corp of Engineers and the Bureau of Reclamation
- State/local governmental entities- regional and local flood control and watershed groups

- Private investors - hydropower and water management

Each of these groups has to abide by a set of rules and regulations. It is important to realize that most of the dams constructed in the United States and internationally have not been subject to stringent environmental review. In the United States the environmental review of dams did not begin until the National Environmental Policy Act was passed into law in 1969. Prior to that dams would be constructed with little or no thought or concern to the resources or people who were directly impacted. Today all Federal dams or federally funded dams or dams that impact Federal lands must undergo NEPA compliance and review, including impacts to endangered species, clean water and air, and cultural resources.

Private dams that generate electricity and utilize Federal funding or impact public resources must be licensed by the Federal Energy Regulatory Commission (FERC). The FERC issues licenses varying in length from 30 to 50 years. Private dams must undergo periodic review and relicensing in order to remain in place. Federal dams do not have the same requirements for periodic review and relicensing and therefore their impacts may extend for a significantly longer period of time than private dams.

Decommissioning of private dams and environmental review of Federal facilities is being initiated for several reasons:

- Concerns over the safety of the existing dams and their appurtenant structures

- Impacts to the ecological resources upstream and downstream of the dams
- The cost of maintenance and management of existing facilities in comparison to the lost benefits from the environment and the costs of meeting specific legal requirements
- Community and ecosystem revitalization
- Recovery of the costs that went into the original construction of the dams

Over the past 10 years over 200 dams (mostly private) have been removed in the United States. Today there are over 290 dams in the United States and 16 internationally that are actively being reviewed for potential decommissioning. The size of these dams range from small dams of less than ten feet to Glen Canyon, which is over 500 feet tall. Most recently the Corp of Engineers four large dams on the Snake River underwent a national review with a sizeable segment of the population requesting that the four dams be dismantled and removed.

The Role of Reviewer and Non-Governmental Organizations

There has been little consistency in the approach taken so far on the appropriate role of federal agencies and other organizations in the planning leading up to the decision to remove or decommission a dam. Recently the H. John Heinz Center for Science, Economics and the Environment (2002) published a scientifically peer reviewed journal on the science and decision making steps that should be taken when reviewing the potential for dam removal.

Internationally, increasing numbers of people are questioning the building of new dams, the management of existing dams and in many cases demanding the restoration of ecological and social integrity to impacted rivers. Currently reviews of existing dams is ongoing in Europe, Russia, Siberia, New Zealand, Turkey, Canada, Australia, Indian and Japan. Ongoing struggles over the construction of new dams is primarily occurring in developing countries where the potential for large-scale development is funneling construction funds into governments and international businesses, rarely assisting local populations or environments. In China, the massive Three Gorges Dam on the Yangtze River has attracted national and international attention as over 1 million people are relocated and the potential for substantial increases in sedimentation, water pollution and regional impacts are debated.

Non-governmental organizations (NGO's) play a critically important role in the review and debate on the role and impact of dams on the world's rivers. NGO's support three important ingredients in process that ultimately decides what decisions are made:

- Improved public policy
- Grassroots organizing
- Public education and political credibility

Public policy related to dam construction is defined by those who are in political control and wish to increase their position of power. These entities have historically driven water development. NGO's help to bring the issues out and provide a forum for alternate perspectives to be discussed debated and explored. NGO's also provide an organizational nexus for grassroots politics and alternative policy and issue debate. Grassroots organizations of disenfranchised groups and individuals can help in providing alternative forums and the raising of public interests. Lastly, NGO's provide an important function in educating the public and decision-makers. People in control rarely actively bring alternative information forward. NGO's provide an important vehicle for issue education and debate.

IV. THE EFFECTS OF DAMS AND RIVER REGULATION. WE NEED TO START AT THE BEGINNING

River development historically has meant the damming and diverting of rivers. To understand and put into context what affect this has on downstream environments, it is necessary to identify and articulate how a natural river responds to watershed influences. This characterization can be categorized into two broad components:

- The **physical** processes
- The **biological** processes

<u>Physical Processes</u>. A river is a representation of the watershed in which

it exists. Typically a river will have a high-energy upper section; a middle section where the energy and mass find equilibrium; and a slow moving lower section where deposition occurs. A river defines itself by the substrate that makes up the watershed, the amount of runoff available, its length, and the chemical composition of the soils and riparian area of the watershed. Rivers find their equilibrium through a long balancing act between available water and the substrate through which the river flows.

Hydrologically rivers undergo seasonal cycles of high and low flows corresponding to the upstream water supply and runoff conditions. In many river basins this correlates to high flows during certain times of the years and low flows during other times. The high flows initially pickup and erode sediments as the flows increase and then redeposit them as the runoff decreases.

The equilibrium balance that occurs in the physical system occurs on several different time scales.

- Real-time - related to a minute-by-minute distribution of sediments and water in the local environment
- Seasonal/Annual - based on the yearly high and low flow pattern
- Decadal - based on longer term trends in rain, snow and runoff patterns

Native species of plants, birds, mammals and fish develop specific life history strategies to conform to the variability of the riverine system.

Biological Processes. As the river defines itself physically, the biological components evolve on a concurrent timeline reflective of the habitats, water quality and food resources available. Typically the upper sections of a river will support cold water species of fish, have lower nutrients and a specialized group of insects and plankton. A *biological continuum* evolves as the river flows downstream with a broader array of riparian and aquatic species developing as the habitat diversity and water quality changes. The resulting aquatic and riparian biological community reflects a continuum connecting the upstream ecosystem with the downstream (Cummins, 1974). Understanding the evolution and stratification of the riverine system is essential in order to design effective restoration approaches (NRC, 1992).

- **Fragmentation of the river environment**

Dams and water development *fragments* and *disrupts* the natural physical and biological processes of rivers. This happens as flowing rivers are changed from moving entities into reservoirs and slack-water environments. Reservoirs do not follow the same limnological patterns that natural lakes do (USEPA, 1984). When rivers are dammed major physical and biological changes begin to occur immediately:

- Dams become barriers to the upstream and downstream movement of fish, insects and amphibians.
- Reservoirs trap sediments that were historically essential for downstream deltas and river channels for habitat and floodplain development
- Reservoirs modify the water quality of the river system

- Reservoirs change the downstream water quality through the chemical changes that occur in reservoirs
- Dams modify the flow regimes downstream usually by taking away the life defining high flows, reducing the minimum flow and modifying the daily, seasonal and annual flow patterns of the river
- Biological food web modifications occur and domino their effects upstream and downstream

The problems are magnified as more dams are added to a river system, resulting in an increased and cumulative loss of resources, habitat quality, environmental sustainability and ecosystem integrity. Non-native species, modified water quality, loss of system dynamics and loss of the ability to maintain a continuum of an ecosystem result in disrupted and ecologically corrupted river systems.

In summary, dams affect the natural hydrologic patterns, which ultimately affect the geomorphic complexity of the river, which impacts that biocomplexity of the ecosystem and ultimately affects the species that live in and are supported by the river. Dams disrupt the natural hydrology and biological species across the entire flow regime. An example in the United States is the cumulative affect that the closure of Columbia and Snake River dams have had on the numbers of salmon. The loss of these species has had a significant effect on the economic and social well being of the people and have directly impacted the ecological integrity of the entire river system.

V. WHAT HAVE WE LEARNED AND WHAT OPTIONS EXIST?

- **Dams and water development has an effect that must be qualified and quantified before *useful* restoration or proper river management can occur.**

Studies conducted by scientists and managers across the world have documented the effects that dams have had on river ecosystems and societies. These effects have been documented in scores of technical papers and books (McCulley 1996, Collier, et. al, 1996, Ward and Stanford, 1979). The key issue is that no two rivers are the same. Each river is unique and requires an approach that takes into consideration the physical and biological aspects of the watershed and hydrological system.

Development of dams compromises the normal processes of rivers. Adequate procedures to evaluate the impacts and recommend remedial actions must be based on quantifiable information about the river and watershed. There is no cookie cutter approach to river restoration.

- **Dams compromise the dynamic aspects of a river. The dynamic aspects of the river are what define its character, not the *average* conditions of controlled dam operations.**

  Natural rivers are a function of the flow, the quantity and character of the sediment in motion through the channel and the character or composition of the materials that make up the bed and banks of the channel (Leopold, 1994). The defining river discharge includes both high and low flow elements. The high flow elements initially defines the available habitats and often serves as the biological queues for the initiation of spawning, nesting, seed dispersal and insect hatching. As dams and flow modifications control rivers, the physical processes are constrained and the biological processes are disrupted. The result is a loss of biological integrity as species are unable to complete essential life history strategies. The result is that critical ecosystem elements are lost or modified to such a point that they are biologically unusable.

The resulting modified habitats often create environments that are more conducive to non-native and exotic plant, fish, snail, insect and animal species (MRSG, 1982, NRC, 1996b). These resulting non-native species often out compete the native species and end up developing ecosystems that are unstable, conducive to disease vectors, and unable to support the historical environmental and social components. The short-term gain in having a reservoir or hydroelectric plant may not compensate for the loss of critical ecosystem functions.

- **Dam and reservoir management must take into consideration the historical environmental and social resources.**

Historically dam and river management has focused on the development of reservoirs and the more efficient movement and control of water. Development has often been justified based on the value to be returned to the people and the increased efficiency of water management. Undoubtedly some of these goals are important from a social perspective (Water Resources Environment Technology Center, 1998). These development goals however have often come at a significant price, the loss of river ecosystems, the loss of social integrity, and the loss of the ability for a watershed to maintain its ecological sustainability.

It is essential that the long-term impacts to the environmental and social environments be considered when river development is being proposed. It is essential that the social and environmental costs be taken into consideration when dams are being debated. Intact and functional river systems will support many more people in the long run than the short-term benefits gained from undefined river development.

VI. RIVER RESTORATION. ALTERNATIVES TO DAMS AND TOOLS ARE NOW AVAILABLE TO RETHINK AND MODIFY HISTORICAL APPROACHES

Around the world people are questioning the results that the decisions to build dams has brought. These questions are not about what the dams provided. These debates are over the residue of what the dams have brought - corrupted ecosystems, lost species and impacts to cultural resources. Societies and people are asking whether anything can be done to lessen the impacts and restore parts or all of the lost ecosystem structure and integrity. Some of the ideas that are being formulated include.

- **Managed Flow Regimes from Dams.**

In 1996 the U.S. Department of the Interior conducted an experiment on the Colorado River, Glen Canyon Dam, to determine if an artificial flood through the Grand Canyon could restore important sediment and habitat resources for native fish and bird species (Wegner, 1996, 1997). The experimental flood was a short-term success in restoring important ecosystem physical and biological functions. The long-term sustainability of the high flow experiment has not proven to be stable. Alternative operations were officially determined through the scientific studies completed at Glen Canyon Dam (USDI, 1995).

- **Retrofitting Dams.**

On several dams across the United States and the world federal, state and tribal entities are retrofitting dams in order to provide increased management and operation flexibility (COE, 1993, Collier, et al, 1996). Several different types of retrofits are being looked at:

    - Thermal modification (Flaming Gorge, Shasta, Glen Canyon)
    - Fish Screens (Bonneville, Lower Granite)
    - Increased spillway capacity

- **Watershed Habitat Restoration.**

Habitat restoration on selected tributaries and mainstem habitats may help to provide necessary areas for spawning, juvenile fish rearing, riparian habitats for birds, and increased bank stability. Specific examples include:

    - Creation of buffer zones along the riparian corridor (NRC, 1992)

    - Restoring spawning habitat (Columbia River Inter-Tribal Fish Commission, 1999)
    - Improved habitat management (NRC, 1992, NPPC, 1992a, 1992b)
    - Watershed area management plans (Hualapai Tribe, 1999)
    - Development of migration corridors (NRC, 1992)

- **Reservoir Management.**

Many migrating fish species have time critical life stages that require movement from fresh to salt water environments. Reservoirs slow down water and increase the amount of time it takes a young fish to move from its upstream habitat to its downstream habitat. Drawing down reservoirs during critical times of the year has been shown to increase the velocity of the river and reduce the amount of time that young fish are moving from one habitat to another (NPPC, 1996 a,b,c). The Northwest Power Planning Council is currently evaluating the potential to increase the river flow through the Snake and Columbia River system in an effort to move juvenile salmon through the system.

    - Reservoir drawdown programs (USCOE, 1993)
    - Increased river velocity (NPPC, 1999 a,b)

- **River System Management.**

On many river systems multiple dams control the flow of water. Management of multiple reservoirs and dams requires additional cooperation, planning and system management efforts. Flood control, hydropower generation, irrigation requirements, and flushing flows require a significant amount of coordination. Specific examples include:

- Columbia River management (USCOE, 1993)
- Colorado River management (BOR, 1995)
- Yangtze River (Probe International, 1991)

- **Modification of Reservoir Water Quality.**

On smaller reservoirs water quality considerations increase under conditions of extensive thermal and density stratification. Anaerobic conditions lead to increased migration and transformation of heavy metals into the volatile and potentially dangerous constituents. If these constituents are taken up by the plankton, they can lead to a cumulative impact to the forage fish, the non-game fish and eventually the game fish species that are of economic, social and recreational importance. Modifications to reservoir water quality can include:

- Aeration to break up stratification (USEPA, 1984)
- Increasing the turnover rate of reservoirs (NRC, 1992)
- Impacts on heavy metals (Wegner, 1999)

- **Dam Decommissioning.**

Across the United States and the world, NGO's, private companies and governments are evaluating and implementing actions to decommission specific dams. The dams being targeted for study and evaluation are those that have caused considerable harm to the riverine ecosystems, have fragmented critical river systems and have led to considerable negative impacts to social and economic conditions downstream.

In the United States hundreds of small dams have been removed. In the majority of these efforts little scientific information was available to assess the pre and post dam effects. Two specific examples include:

- Woolen Mills Dam – Milwaukee River, Wisconsin
- Edwards Dam – Kennebec River, Maine

These efforts have led to a considerable increase in the sharing of information among scientists around the world to document impacts caused by dams.

- **Dam Review Efforts in the United States**

Recently two national efforts have produced reports evaluating the state of the knowledge regarding dam removal and river restoration, the *H.John Heinz III Center for Science, Economics and the Environment* and the *Aspen Institute* (2002). The Heinz Center (2002) has completed a peer-reviewed assessment of the state of the science of small dam removal and has assembled a list of recommendations that are pertinent to the study of dams and river everywhere. Specific conclusions that can be drawn from the Heinz Center efforts include the following:

1. **Dam Removal Decisions must follow a specific process that includes**:
    a. Establishment of objectives and the collection of data
    b. Identification of the complete range of issues

c. Assessment of likely outcomes

d. Transparent decision process

2. **A summary of indicator parameters should be developed to guide the decision process. The information should be locations specific and assess response with and without the dams. The parameters should include:**

    a. Physical

    b. Chemical

    c. Biological

    d. Economic

    e. Social issues

3. **Uncertainty must be recognized as an important element in the decision process. Uncertainty should be integrated into the decision process through an adaptive science and management effort.**

The recommendations developed by the Heinz Center and the Aspen Institute is being used nationally to further the study and debate of the role of dam removal in river and ecosystem restoration. It is clear that a scientifically driven process is necessary to ensure adequate assessment and to guide administrative decision-makers.

- **Ongoing Dam/River Studies**

Examples of specific river systems being studied include:

- Colorado River, USA (Wegner, 1997)

- Elwha River dams, USA (USDI, 1994)
- San Clemente Dam, Carmel River, USA
- Lower Snake River dams, Snake River, USA

VII. SUMMARY

It has been documented that dams have a negative impact on natural river systems. Fragmented habitats, lost ecosystem production and connection, introduction of exotic species and diseases, and increased water quality problems are but a few of the impacts seen when natural riverine processes are constrained. This does not mean that all dams are bad. Certainly the development of water resources has played an important and valuable role for societies and cultures or people. Today we must develop adaptive management approaches to meeting our social and environmental goals (Meretsky, et al, in press). The issues facing us today is if the process we have been traditionally following makes sense for the future and if certain rivers can be sustained through a combined effort of reoperation, management and restoration.

We are poised at a threshold regarding the ecological health of the world's rivers. At no time in the world's history have we had both the technology and ability to restore critical riverine ecosystem functions. Balancing the societal short-term needs for water, electricity and transportation with the long-term needs for river ecosystem sustainability and integrity requires a unique set of people, agencies, governments and private groups to cooperatively work together. Science can provide the basics for outlining the existing conditions and the options for restoration. Implementation of actions requires people with initiative and vision for the future.

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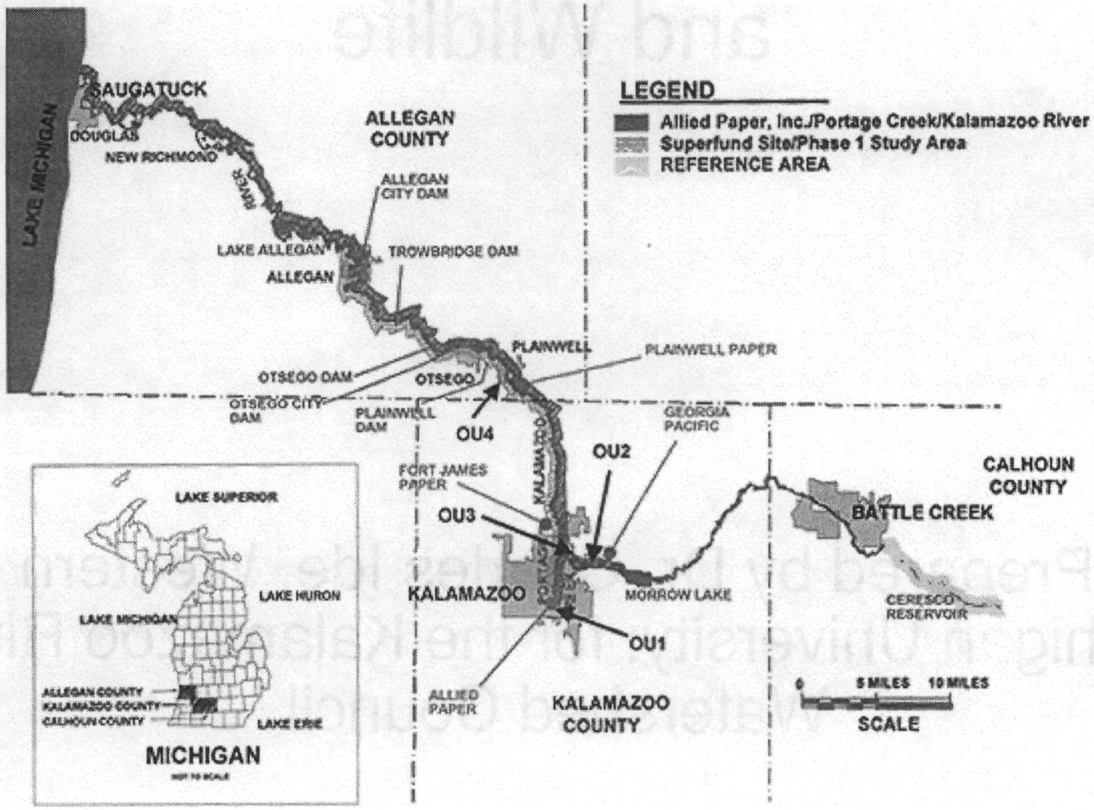
The Kalamazoo River Superfund Site: PCB Contamination in Soils, Sediments, and Wildlife

Prepared by Dr. Charles Ide, Western Michigan University, for the Kalamazoo River Watershed Council

Kalamazoo River Watershed – Part of the Lake Michigan Basin



Environmental Concentrations of PCBs

- **One ppm is 1 part in 1,000,000. The common unit mg/liter is equal to ppm. Four drops of ink in a 55-gallon barrel of water would produce an "ink concentration" of 1 ppm.**
- **One part per billion is 1 part in 1,000,000,000. One drop of ink in one of the largest tanker trucks used to haul gasoline would represent 1 ppb.**

Polychlorinated Biphenyls (PCBs)

- **Synthetic organic chemicals; do not occur naturally;**
- **Manufactured for electrical system uses - insulators, transformer boxes on power poles;**
- **Non-flammable, do not easily degrade; many uses on consumer goods (rubber, pesticides, paints, inks, weatherproofing)**
- **Ubiquitous on the planet (air,soil, water)**
- **Over 3.4 billion pounds released into the environment**

Kalamazoo River Superfund Site: Sources of PCB Contamination

- **Paper mill effluent overflow, contaminated with PCBs from recycling carbonless copy paper, was originally discharged directly to the Kalamazoo River**

- **Landfills were constructed along the river in the late 1950s as a series of settling lagoons used until 1977 to dewater PCB contaminated paper-making residuals**

- **Landfills with PCBs, for example, at concentrations of 158-330 ppm are part of the superfund site (Blasland, et. al., 1995).**

Kalamazoo River Superfund Site: Kalamazoo River Operable Unit

- The Kalamazoo River Operable Unit spans 80 miles of the river's length, from Morrow Dam at the outlet of Morrow Lake to the river mouth at Lake Michigan.

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Sandra and Joseph Jacobson, Wayne State University

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- PCB's eaten by crawfish which was eaten by an eel; eel migrated to the tropics (Sargasso sea off Bermuda) to spawn and die; released by disintegration of eel, carried to water surface, volatilized and carried north

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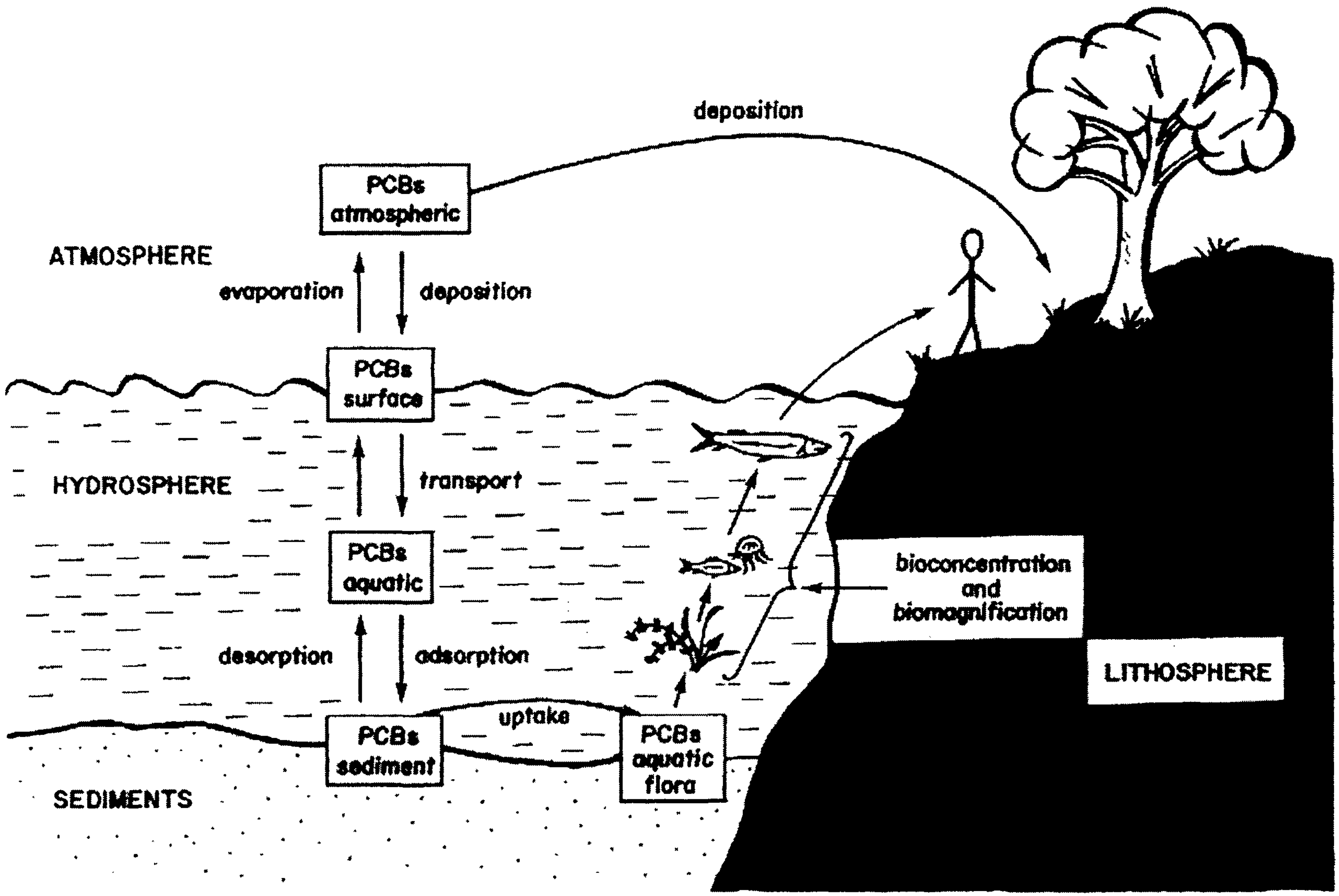

Pathways for the cycling and transport of PCBs in the environment

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- Bald eagle
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- Mink
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- Snapping turtle
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- Therefore, no consumption is advised for women and children regarding bass from the 80 mile long Kalamazoo River superfund site.

Protection of Human Health

- **The most important point, not yet adequately addressed, is the fact that people are currently eating contaminated fish from the Kalamazoo River.**

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Summary

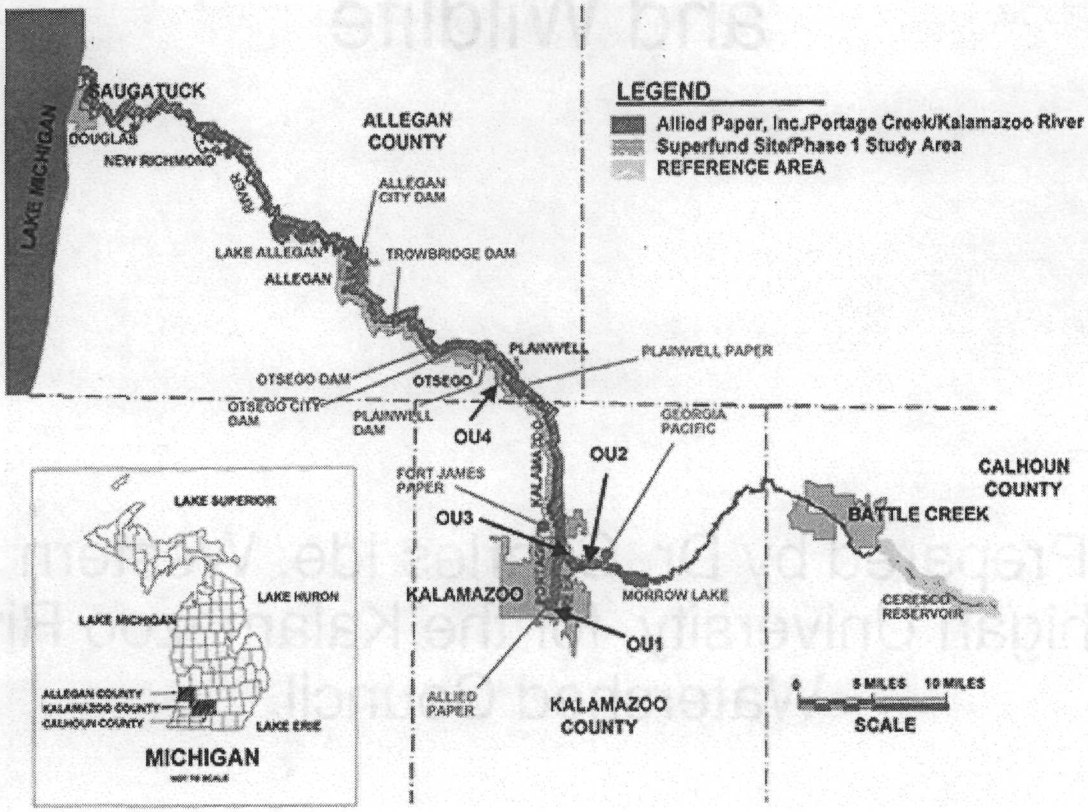
- PCBs are present in the Kalamazoo River at concentrations that are unacceptable for protecting ecosystem and human health

- Contaminated in-stream sediments and flood plain soils should be remediated to PCB levels that, at the very least, protect pregnant women and young children who consume fish from the river.

The Kalamazoo River Superfund Site: PCB Contamination in Soils, Sediments, and Wildlife

Prepared by Dr. Charles Ide, Western Michigan University, for the Kalamazoo River Watershed Council

Kalamazoo River Watershed – Part of the Lake Michigan Basin



Environmental Concentrations of PCBs

- **One ppm is 1 part in 1,000,000. The common unit mg/liter is equal to ppm. Four drops of ink in a 55-gallon barrel of water would produce an "ink concentration" of 1 ppm.**
- **One part per billion is 1 part in 1,000,000,000. One drop of ink in one of the largest tanker trucks used to haul gasoline would represent 1 ppb.**

Polychlorinated Biphenyls (PCBs)

- **Synthetic organic chemicals; do not occur naturally;**
- **Manufactured for electrical system uses - insulators, transformer boxes on power poles;**
- **Non-flammable, do not easily degrade; many uses on consumer goods (rubber, pesticides, paints, inks, weatherproofing)**
- **Ubiquitous on the planet (air,soil, water)**
- **Over 3.4 billion pounds released into the environment**

Kalamazoo River Superfund Site: Sources of PCB Contamination

- **Paper mill effluent overflow, contaminated with PCBs from recycling carbonless copy paper, was originally discharged directly to the Kalamazoo River**

- **Landfills were constructed along the river in the late 1950s as a series of settling lagoons used until 1977 to dewater PCB contaminated paper-making residuals**

- **Landfills with PCBs, for example, at concentrations of 158-330 ppm are part of the superfund site (Blasland, et. al., 1995).**

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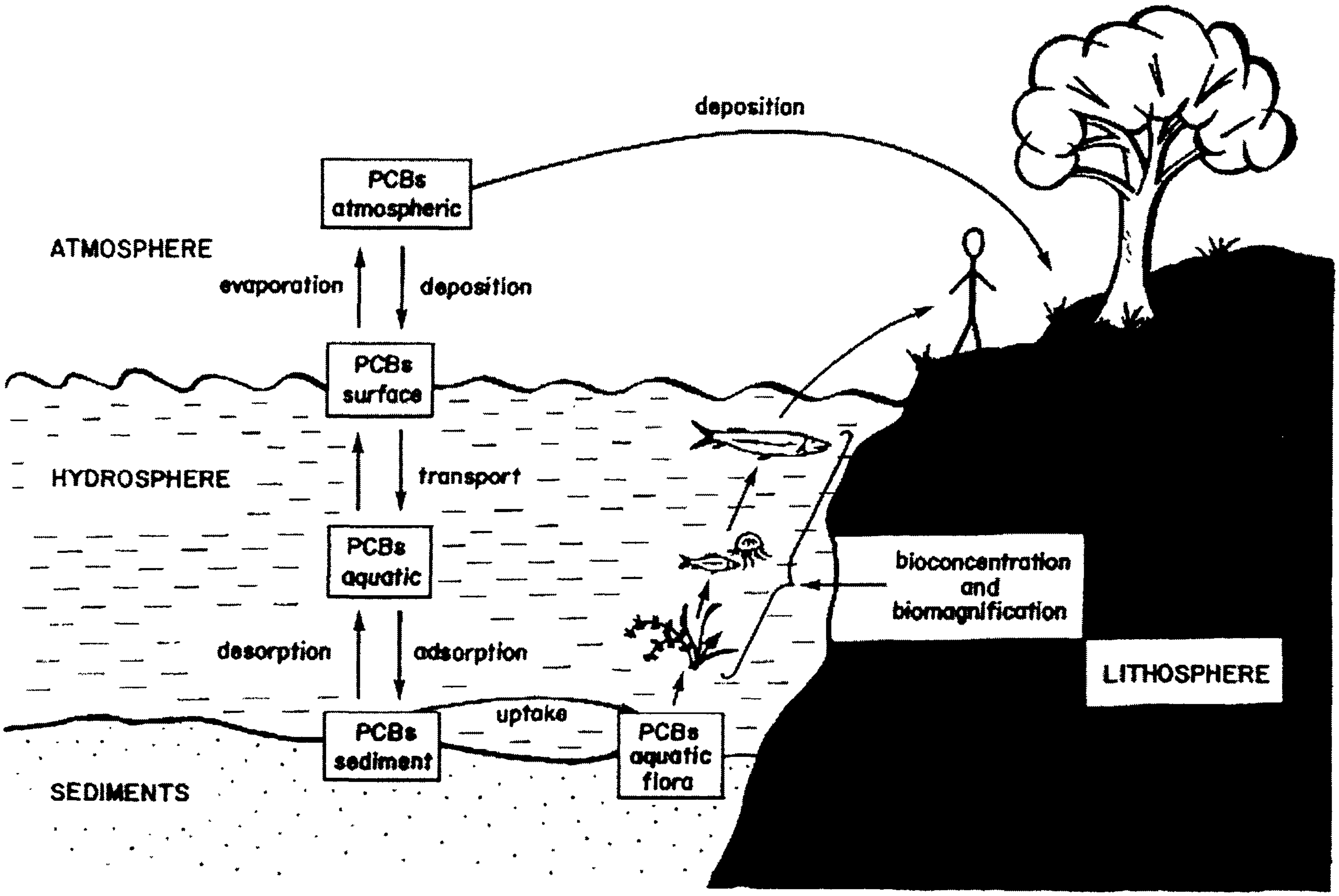

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